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Tribal Crash Reporting Toolkit: Data Analysis Tool

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Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
B/C	benefit-cost ratio
BIA	Bureau of Indian Affairs
CMF	crash modification factor
CPST	child passenger safety technician
EMS	emergency medical services
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GDL	graduated driver license
HSIP	Highway Safety Improvement Program
MCSAP	Motor Carrier Safety Assistance Program
RSA	road safety audit
RSDP	Roadway Safety Data Program
SHSO	State Highway Safety Office
SHSP	Strategic Highway Safety Plan
SPF	safety performance function
TSP	transportation safety plan
TTAP	Tribal Technical Assistance Program
TZD	Toward Zero Deaths

Introduction

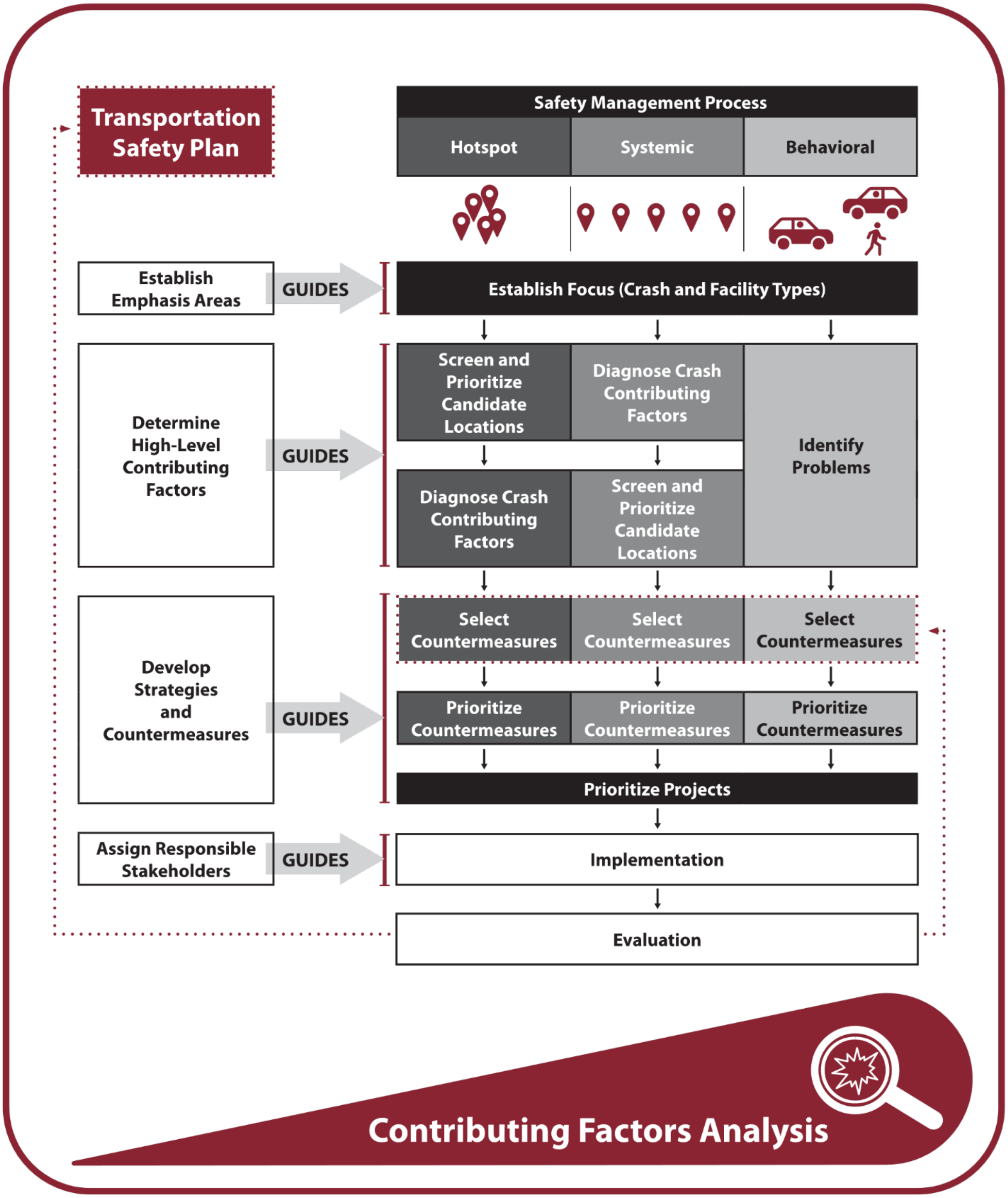
This tool is designed to help Tribal governments analyze crash data in their jurisdictions. This tool is not intended to be exhaustive, but it is intended to give Tribal governments a good understanding of the kinds of safety analyses they can perform and how the results can help define a safety program and its components. The topics in this tool are organized around common types of analyses:

- Contributing factors trends in crashes;
- Location-based and risk-based roadway analyses;
- Behavior-focused analyses; and
- Exploratory analyses that can help a Tribe identify important focus areas for safety improvement.

Tribes can use the database tool that is part of the toolkit (see the *Tribal Crash Reporting Toolkit Manual* for a description) or they can use their own databases to access crash data. This data analysis tool recognizes that Tribes may have many reasons to analyze crash data and that some of those analyses may be sensitive while others may be designed specifically to share with other governments and agencies.

The main motivation Tribes have for analyzing crash data is to improve safety. The analytic results are helpful in pointing to concerns—the factors that contribute most to crash frequency and severity—and in identifying locations, crash types, and sub-groups of people representing greatest opportunities for safety improvement. Tribes use analyses to support grant requests and allocate resources. Tribes also use analyses for planning efforts such as the transportation safety plan and other documents or to meet reporting obligations.

Grant programs and processes are described in the final section of the document.


Transportation Safety Plan
Safety Management Process
Hotspot
Systemic
Behavioral
Establish Emphasis Areas
GUIDES
Establish Focus (Crash and Facility Types)
Determine High-Level Contributing Factors
GUIDES
Screen and Prioritize Candidate Locations
Diagnose Crash Contributing Factors
Identify Problems
Diagnose Crash Contributing Factors
Screen and Prioritize Candidate Locations
Develop Strategies and Countermeasures
GUIDES
Select Countermeasures
Select Countermeasures
Select Countermeasures
Prioritize Countermeasures
Prioritize Countermeasures
Prioritize Countermeasures
Prioritize Projects
Assign Responsible Stakeholders
GUIDES
Implementation
Evaluation
Contributing Factors Analysis

Contributing Factors Analysis

This section presents analyses that focus on the factors that contribute to crashes. This approach is used in all safety analyses. In roadway safety analyses, it is called *diagnosis*. In behavioral analyses it is called *problem identification*. In transportation safety planning, it is the basis for *identifying focus topics*. In safety program management, it is used to identify *at risk* groups and risky behaviors. This is the same as the analyses used to develop focus areas in a Strategic Highway Safety Plan.

Contributing factors analysis uses crash data elements that record the sequence of events, crash contributing circumstances, driver condition and actions, and crash types. The simplest analyses use a single data element, like *Crash Type*, to categorize crashes and find those factors that contributed to the crash. More complex analyses combine more than one data element, like *Crash Type* and *Roadway Contributing Factor,* to develop a more detailed understanding of crashes and how crash risk and severity change under varying conditions. Their many uses are described in the remaining sections of the document. This section describes how contributing factors analyses are conducted.

Simple Approaches

Tribes have developed TSPs that address engineering and behavioral issues. The plans are similar to a State SHSP in that they identify specific focus topics, present analyses to show the extent of the safety issues, and list countermeasures that the Tribe may implement to address those issues. The examples that follow are drawn from existing Tribal safety plans.

Engineering example:

Tribes can look at single data elements in a crash database to identify the most prevalent factors that contribute to crashes. They can also look across years to examine the trends for the important contributing factors. This type of analysis can help to quantify the Tribe's crash experience in ways that lead naturally to setting the focus on mitigating the most frequently occurring factors. For example, a 2016 analysis of *Crash Type* (this is analytically derived from crash harmful event codes) by one Tribal Nation showed the following proportions.

Crash Type	
Struck an animal:	34 percent
Ran off road:	30 percent
Struck fixed object:	20 percent
All others:	16 percent

The analysis of "crash types" is a common approach in TSPs. The analyst looks at crash data elements such as first harmful event and most harmful event and runs a frequency analysis to identify those factors that are most often coded. When performed consistently (with the same list of crash types) for several years, the analysis can show the Tribe's safety decision makers where the trends are improving or getting worse. One concern with this type of approach is that there may be a lack of consistency over years as different analysts combine harmful event codes differently. For example, many analysts would combine "run off road" and "struck fixed object" into a larger grouping labeled "roadway departure" crashes. In this example, combining those two would result in roadway departure crashes being by far the most common.

Taken just as a single result with no trend lines, this analysis clearly shows that, within the Tribe's jurisdiction, the largest number of crashes involve animal strikes and run-off-road events. Without any further analysis, the Tribe could use that information to establish a safety focus on animal collisions and roadway departures. These two focus topics, as part of a Tribe's TSP, would account for well over half of the crashes the Tribe would like to address. The TSP would then identify a range of treatments available to address these topics including infrastructure, education, enforcement, and emergency medical services (EMS) improvements.

Behavioral example:

A similar analysis, this time examining *human factors,* found that the single highest category was "missing" (accounting for 25 percent of all drivers in crashes). Nationally, over 90 percent of crashes are coded with at least one factor related to driver condition or behavior as having contributed to the crash. By comparison, with 25-percent missing, the analysis points to a data quality problem—reporting of driver contributing factors is incomplete. This example shows that one possible use of simple, single-data-element analyses is to help the Tribe identify data quality issues (such as missing data). Other human factors cited in the report include driver inattention, unsafe speed, impairment, and inexperience. The Tribe can use the information to identify behavioral countermeasures (e.g., enforcement, training, education, and others) that could address the specific problems found. For example, the Tribe found that 20 percent of crashes involved teen drivers under 18 years old. They know that those drivers make up an estimated 10 percent of drivers in the Tribal jurisdiction. That would mean that teen drivers younger than 18 have a risk factor of 2—their crash involvement percentage divided by their percentage of the driving population. In other words, their crash risk is *double* what would be expected based on their portion of the population. Based on that information, the Tribe could decide to develop a behavioral program including education, enforcement, and outreach focused on teen drivers. Just as with the earlier example, the countermeasures need not be limited to a single type (behavioral or engineering). Effective countermeasures come from approaches and disciplines.

Advanced Approaches

This section describes some advanced approaches to analyzing crash experience. The first two examples are focused on engineering and behavioral problem identification as in the examples presented in the previous section. In these more advanced approaches, the analysis shows successively more specific layers of the problem. The cross-tabulation example shows how an analysis can simultaneously explore contributing factors and severity.

Engineering example:

More advanced analysis of crash contributing factors can include more than one data element or can filter to examine a specific contributing factor in selected crash types or circumstances. For example, in the simple analyses, a Tribe found that 30 percent of its crashes involved a vehicle running off the road. To get more specific details, the Tribal government could examine circumstances of that subset of crashes.

In this example, the analyst could apply a filter to select *only* the run-off-road crashes as a first step. In this example, that resulted in a subset of 30 crashes (out of an original 100 crashes in the database). Then, in a second step, the analyst could look for other factors that may be important. A typical analysis might look at what percentage of run-off-road crashes happened at curves and what percentage of them happened at locations with narrow shoulders.

Taking the example further, suppose that 42 percent of the run-off-road crashes happened on curved segments of roadway. A follow-up analysis might ask what percentage of *all* crashes happen on curves. In this example, only 12 percent of all crashes happen on curves, so the fact that 42 percent of run-off-road crashes happen on curves is a strong indication that curves are particularly prone to run-off-road crashes. One way to express that is to calculate the relative risk. In this example, that is the ratio of 42/12 (the ratio of the two percentages). In other words, the risk of a curved segment being indicated in a run-off-road crash is 3.5 times higher than it is for crashes in general.

This analysis could go further. The analyst might look at the radius of curvature to see if curves with a larger radius are less likely to see run-off-road crashes than are those with a small radius. The analyst might also look at shoulder width on curves to see if narrow shoulders are more likely to be linked with run-off-road crashes. This kind of sequential analysis is useful in helping a Tribe decide what locations might offer the best opportunity to address the specific problem of crashes when a vehicle runs off the road. It can point to specific locations where a treatment may be needed. It can also point toward a systemwide solution in which locations that share characteristics (like small curve radius and narrow shoulders) are identified and prioritized for treatment. This is illustrated in Figure 1.

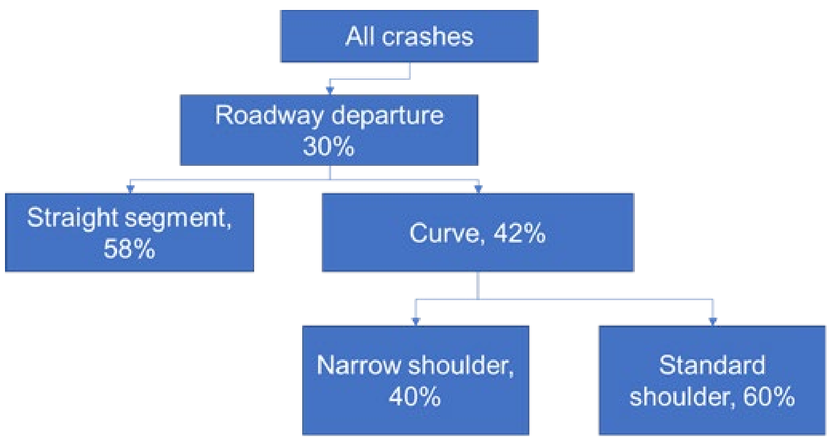


Figure 1. Run-Off-Road Crashes Sequential Analysis

Behavioral example:

When the Tribal government identifies the need for a focus on behavior to improve safety, contributing factors analyses can follow a similar path of increasingly specific and more complex review. For example, the initial analysis might show that 20 percent of crashes involve teen drivers under 18 years of age. Knowing that people in that age range make up only about 10 percent of the population driving in the Tribal area would already demonstrate that teen drivers pose a high crash risk. The Tribe might decide to further characterize those crashes in several ways by asking follow-up questions like:

1. What percentage of the teen drivers involved in crashes are male? And what percentage of all teen drivers are male?

2. What percentage of crashes involving teen drivers also show speeding as a factor in the crash? How does that compare to the percentage of all crashes showing speeding as a factor?
3. What are the most prevalent crash types involving teen drivers? Do those crash types differ from the types the Tribe identified as focus areas (e.g., animal strikes and run-off-road crashes)?
4. How does the occupant protection usage rate for crash-involved teen drivers differ from the overall driver usage rate?

The only limit to the follow-up questions is the data itself. If the crash data, and other supporting information (like demographics and observational studies of occupant protection use), can support the analysis, the Tribe can get answers to the questions that interest them. With the more detailed results, the Tribe can develop programs that target specific behaviors and specific subsets of the population. Behavioral safety programs are described in more detail later in this tool. There are several resources that a Tribe can use to explore effective strategies to mitigate the behavior-related safety problems they find, including the National Highway Traffic Safety Administration's *Countermeasures That Work.*[1]

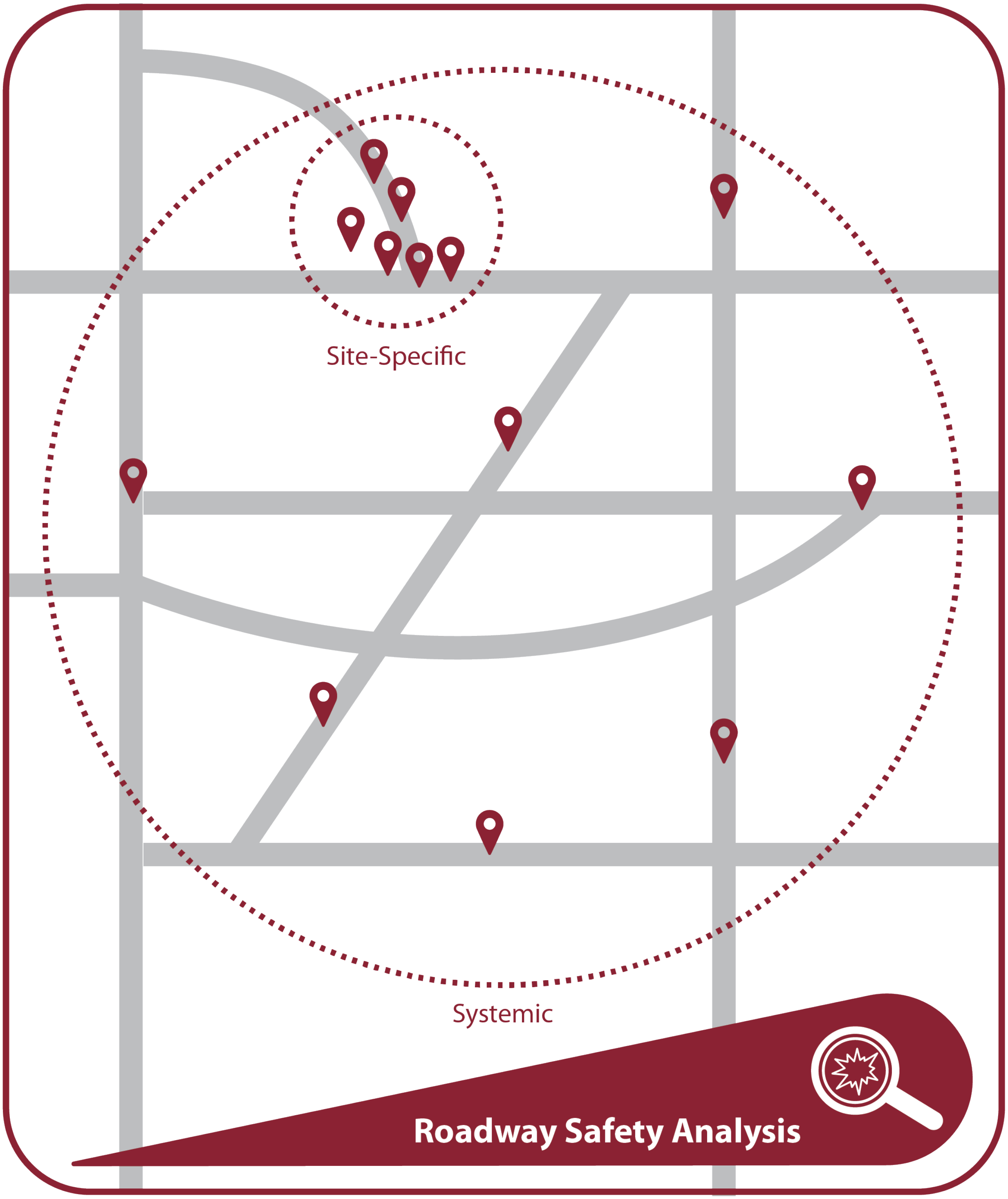
Cross-tabulation example:

Tribal decision makers may want to look at more than one contributing factor at a time, or, they may wish to consider a contributing factor *and* crash severity simultaneously. A cross-tabulation analysis is a way to consider factors at the same time, or crash factors and severity simultaneously. Table 1 shows that 34 percent of all crashes involve striking an animal but this is the case for only 1 percent of fatal crashes. Conversely, striking a fixed object happens in 40 percent of fatal crashes but only 20 percent in overall crashes.

Table 1. Cross Tabulation of Crash Severity by Crash Type

Crash Severity by Crash Type				
	Fatal	**Injury**	**Property Damage Only**	**All Crashes**
Struck an animal	1%	10%	84%	34%
Ran off road	30%	40%	30%	30%
Struck fixed object	40%	30%	30%	20%
All others	19%	20%	60%	16%

[1] Richard, C. M., Magee, K., Bacon-Abdelmoteleb, P., & Brown, J. L. (2018, April). *Countermeasures that work: A highway safety countermeasure guide for State Highway Safety Offices*, 9th edition (Report No. DOT HS 812 478). National Highway Traffic Safety Administration. www.nhtsa.gov/document/countermeasures-work-9th-edition


Site-Specific
Systemic
Roadway Safety Analysis

Roadway Safety Analysis

This section presents analyses that focus on specific locations and systemic risks throughout a Tribal jurisdiction. This information is intended as an introduction to analytic resources such as the Association of State Highway Transportation Officials AASHTO's *Highway Safety Manual*[2] and associated software tools that can help Tribal governments implement the various types of analysis described. The section includes an overview of the Roadway Safety Management process, a discussion of location-based problem identification, and the contrasts with a systemic approach focusing on the roadway attributes associated with crashes.

Site-Specific Safety Approaches

Figure 2 shows the safety management process as defined in the Highway Safety Manual. The steps in the figure describe site-specific safety approaches.

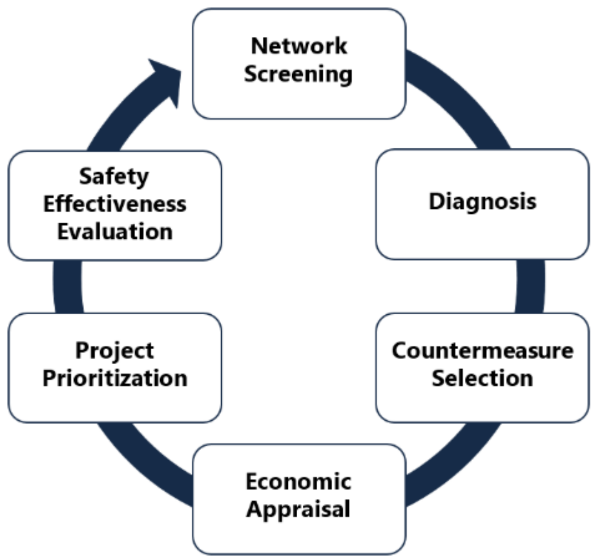


Figure 2. The Site-Specific Safety Management

The process begins with **Network Screening** to find sites with potential for improvement. Network screening is an analysis that compares the crash frequency at each location to the expected crash frequency for locations of that type and for the recorded level of traffic volume.

Next comes **Diagnosis**, which identifies factors that contribute to crashes. This is the same analysis that is described as contributing factors analysis in the first section of this tool. It should align well with the focus areas in a Tribe's TSP.

Countermeasure Selection is finding the most effective ways to address the diagnosed problems. This analysis may use tools and resources such as the crash modification factor (CMF) Clearinghouse or it may be based on past experience with the treatments the Tribe wishes to consider

Economic Appraisal compares the benefits and costs of the selected countermeasures. A typical analysis would express benefits and costs in dollars; however, other methods of examining the

[2] Association of State Highway Transportation Officials. (2010). *Highway safety manual*. www.highwaysafetymanual.org.

expected improvements due to a successful treatment are possible. For instance, a calculation can be used to estimate how long it will take for the countermeasure to pay for itself.

Project Prioritization compares all site-specific results to find the best opportunities to improve safety across the network within a fixed budget. This can be based on the economic appraisal results. The Tribe may have other methods and considerations it will use to select the projects to pursue.

Safety Effectiveness Evaluation tells us if the projects delivered the expected safety benefits. This is a final step, often taken years after a countermeasure is implemented. It provides the Tribe with useful information on what to expect when using the same treatment(s) in the future. Site-specific examples are found in Tribal TSPs. These typically take the form of a description of the crash experience at a location and the engineering countermeasures implemented to address the specific crash types. The Tribal TSPs don't mention use of the *Highway Safety Manual* and, specifically, do not include a network screening step. Nevertheless, the TSPs do include many of the types of analyses described in the safety management process shown in Figure 2. Examples include corridor studies of State highways that pass through Tribal lands, crash history of intersections of State and local roadways, and highway safety analysis of selected locations.

Reliable site-specific approaches compare the long-term safety performance of a set of similar locations. Network screening develops a long-term count of the crashes at an individual location. This number is then compared to the safety performance of an average site with similar characteristics. Average safety performance can be based on experience within a Tribal jurisdiction, statewide safety data, or even national data.

These methods rely on the use of a safety performance function (SPF). The SPF is a curved line showing the relationship between traffic volume and predicted crash counts for each roadway type. Figure 3 provides an example and shows that the site with the highest crash count may not be the one with the best opportunity for safety improvement. In the example, **site A** has the highest long-term crash frequency, but both **sites B** and **C** have room for improvement when their long-term crash frequencies are compared to the SPF. **Site C**, the one with the fewest crashes, represents the best opportunity to improve safety because its long-term crash count is well above the predicted value.

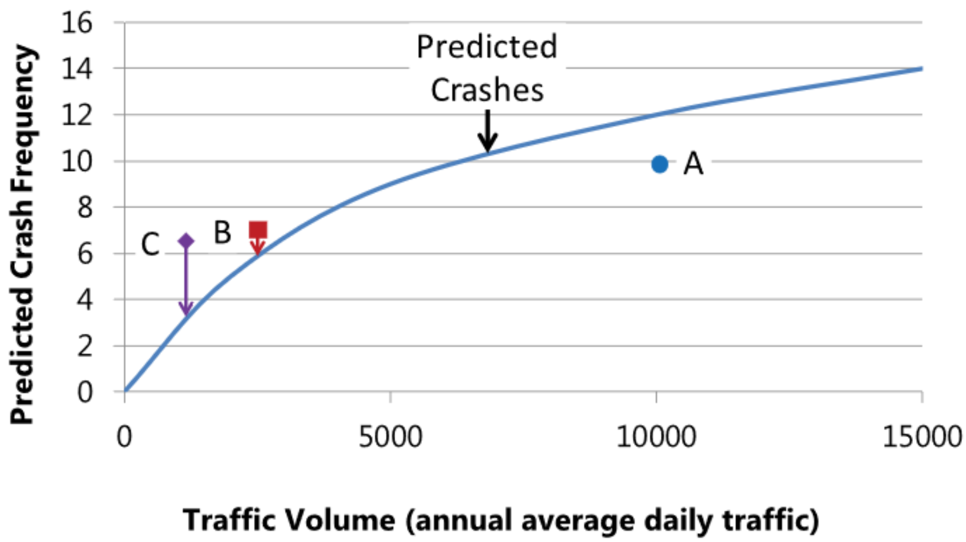


Figure 3. Example SPF

SPFs help avoid one common problem with safety analyses based solely on crash frequency or rate. Take for example, the selection of locations for treatment that are at or below their expected number of crashes (**site A** in the figure)—that is, places where the opportunity to improve safety is not as good as it is for other sites.

Tribes often use methods that do not rely on SPFs or the other advanced network screening methods described in the *Highway Safety Manual*. For example, a simpler *hot spot* analysis can find those locations with high crash frequency or high crash rate (the crash count divided by annual average daily traffic). This is sometimes called a "top 10 list" because it results in a list of (typically) the 10 locations with the highest crash counts or rates. Done carefully (using many years of data and making comparisons only within similar types of roadways), these more traditional methods for identifying candidate locations for treatment can work well. Rate-based approaches, in particular, should help a Tribe focus on those spots with a high crash count. There is a downside, however. Extensive research has shown that simpler methods do run the risk of picking sites based, in part, on what turn out to be random fluctuations. If the Tribe has only a few years of data, that risk increases. The result is that the selected hot spots include at least some locations that would have "improved" through chance fluctuations and the money spent to mitigate crashes at those sites would, potentially, be wasted. Using more years of data can help avoid this problem. Tribes can also perform site-specific follow-up investigations before deciding where to implement countermeasures. Examples are provided later in this analysis tool. The most scientifically valid approach for site-selection would be to use advanced network screening methods whenever possible; however, Tribes can use the alternatives described here with some confidence that they will identify high-crash locations that are good candidates for further study.

To assist in adopting the more reliable methods, Tribes can use SPFs already developed and published in AASHTOWare Safety Analyst[3] or research reports. They can also consult with State DOTs to see if there are State-specific SPFs that would apply well to roads within the

[3] AASHTOWare Safety is a "Software as a Service" (SaaS) platform designed State and local transportation agencies in the area of highway traffic safety management. The platform "ingests," "cleans," and combines data to make it more meaningful and ready for analysis. See www.aashtoware.org/products/safety/safety-overview/

Tribe's jurisdiction. It is important to calibrate national or State-specific SPFs from other States to account for differences in crash reporting and other factors that affect crashes over time and among jurisdictions. States often perform the relevant calibrations and publish a preferred list of SPFs. Tribes can also develop their own SPFs using crash and traffic volume data. State DOTs, NHTSA, and the Federal Highway Administration may be able to assist with the necessary analyses.

Diagnosis is the step that matches the contributing factors analysis described in the first section of this tool. It involves analyzing the types of crashes that happen at each of the spot locations where network screening shows a higher-than-expected count. Diagnostic analysis tells the Tribe if crashes at the location being studied are mostly of a single type (e.g., run-off-road on curves) or if there are types of crashes that could be addressed. It also helps to uncover any common factors such as speed or steep roadside slopes that contribute to the type and severity of crashes. This is an important step because it will help decide which countermeasures to pursue (i.e., those that specifically address the most prevalent crash types and target the contributing factors). Typical countermeasures include Engineering, Education, and Enforcement.

The best approach is the one that gets the Tribal government the information it needs to select effective countermeasures. Diagnosis is very similar to the analyses a Tribe would perform to decide what safety focus areas to include in a TSP—which crash types and contributing factors are most prevalent. Tribes can use online Federal resources to get the latest information on tools available to them, for example, *Reliability of Safety Management Methods: Diagnosis*.[4]

In addition to data mining, the diagnosis process may include field visits to the sites identified from the network screening, which can be helpful during the diagnosis phase. Field observation of driver behavior at a site can often reveal contributing factors that cannot be ascertained from crash report data alone. For more complex locations, a road safety audit can be an effective diagnosis tool.

Countermeasure Selection is the step of deciding what to do about the documented crash experience found in the diagnostic analyses. The best approach to this step is to use a list of available countermeasures that have documented effectiveness based on research. FHWA's *Proven Safety Countermeasures*[5] is an online resource that can give a Tribe easy access to lists of proven countermeasures to address common safety issues. NHTSA publishes *Countermeasures That Work*[6] to highlight behavioral countermeasures. Another resource is the CMF Clearinghouse (www.cmfclearinghouse.org), which provides estimates of safety effectiveness for a wide range of treatments in areas of safety concerns. State DOTs may develop a preferred CMF list based on common countermeasures and their own experience. Tribal governments may choose to use the published CMFs (from the Clearinghouse), State-specific CMFs, or they can develop CMFs based on past projects.

[4] Srinivasan, R., Bahar, G., & Gross, F. (2016, September). *Reliability of safety management methods: Diagnosis*. Federal Highway Administration. Available at https://safety.fhwa.dot.gov/rsdp/downloads/fhwasa16038.pdf

[5] Federal Highway Administration. (2019, December 17). *20 proven safety countermeasures that offer significant and measurable impacts to improving safety* (Web portal, Report No. FHWA-SA-18-029). https://safety.fhwa.dot.gov/provencountermeasures/fhwasa18029/ Print version PDF https://safety.fhwa.dot.gov/provencountermeasures/fhwasa18029/fhwasa18029v2.pdf

[6] Richard et al., 2018.

Economic Appraisal is the analysis of benefits and costs of implementing each potential countermeasure. To do economic appraisal, the Tribe will need three pieces of information for each proposed countermeasure:

- The estimated number of lives saved, and injuries and crashes avoided;
- The estimated costs of crashes, injuries, and fatalities; and
- The cost of implementing the countermeasure.

The estimates of lives saved, and injuries and crashes avoided come from the research behind each CMF. The CMF Clearinghouse provides these values for each crash type and severity level that the CMF addresses. Estimated crash costs come from standardized analyses available from NHTSA, FHWA, the National Safety Council, and others. The important thing is to select a source and apply it consistently for all countermeasures being considered.

Knowing the estimated effect of each countermeasure, the Tribe can convert average crash cost estimates to dollars saved when those crashes, injuries, and fatalities are avoided. The cost of implementing a countermeasure is based on experience and whatever design estimates are available at the time when the economic appraisal is conducted. For example, if a countermeasure is expected to save one life per year at a spot location, and the estimated cost associated with a fatality is $10 million, then the estimated *savings* for eliminating one fatality would be $10 million. The important consideration is to try to be thorough and consistent in developing cost estimates for each potential countermeasure, including annual operating and maintenance costs. That will help the Tribe compare among the countermeasures to decide which to implement.

Finally, economic appraisal develops a benefit/cost ratio for each potential countermeasure. The benefits are the estimated dollars saved if the countermeasure performs as expected in reducing crashes, injuries, and fatalities over a specified period. The costs are the estimated costs of implementation, operation, and maintenance over the same period. The B/C ratio is the present-value benefits divided by the present-value costs. The B/C is favorable if it is above 1.0 and not favorable if it is below that level (a B/C of 1.0 is neutral). The higher the B/C ratio, the better the return on investment—the more lives saved, and crashes avoided per dollar spent on the countermeasure.

Tribes may choose to calculate different indicators than the B/C ratio. A similar calculation (break-even point) can be used to estimate how long it will take for the countermeasure to pay for itself. Tribes may set different priorities than cost-effectiveness or the break-even point. The important thing is to choose a method that makes sense, reflects the Tribe's priorities, and that can be applied consistently for all potential countermeasures so that they can be compared.

Project Prioritization is how the Tribe makes decisions about where to implement countermeasures and which to implement. This step involves comparing the economic appraisals of all potential countermeasures for a single location *and* looking across locations to find the best opportunities to improve safety and respect cultural values. At a single location, it makes sense to pick the countermeasures with the highest B/C ratio as long as the money is available for implementation. It is sometimes better to select a countermeasure with a lower B/C ratio, especially if the Tribe wants to implement something immediately (to prevent some crashes) while waiting for enough funding to implement the more effective (and costlier) countermeasures in the future.

Prioritizing projects among a list of locations is similar to comparing countermeasures for treating a single location. The Tribe needs to decide where the available funding can best be spent to achieve the largest possible safety improvements. That decision may mean that a site with a comparatively large crash problem may get lower priority than a site where the known problems are more easily solved.

Safety Effectiveness Evaluation is the longer-term follow-up analysis that determines if the countermeasures implemented met expectations. This can take several years to accomplish. A basic analysis would compare the numbers of crashes, injuries, and fatalities before and after implementation at the location where the countermeasure was deployed. The *Highway Safety Manual* recommends advanced statistical methods (such as empirical Bayes approaches) to control for regression to the mean. Regression to the mean is when a site's safety "improves" or "gets worse" simply because of random fluctuations. These analyses should be performed by a qualified statistician or someone trained in the techniques. There are tools available to assist Tribes in this type of analysis—an up-to-date list is available through the FHWA Roadway Safety Data Program toolbox (https://safety.fhwa.dot.gov/rsdp/). State DOTs may also be able to help.

Systemic Safety Analysis

Systemic safety analysis allows Tribal governments to focus on specific types of safety problems to solve. It differs from location-specific analysis in focusing first on diagnosis from a systemwide perspective. It can use the same analyses the Tribe would use to determine emphasis areas in its TSP. In a systemic analysis, instead of first finding sites where there are more total crashes than predicted, the Tribe may start with an analysis that identifies the most prevalent crash types. This analysis might show, for example, that the most prevalent crash type is run-off-road crashes and the most prevalent facility type where these crashes occur is on two-lane rural roads. If this is the most prevalent crash type and facility, or the most prevalent type involving injuries and fatalities, the Tribe may decide that addressing the problem on several two-lane rural roads will be the most effective way to improve safety overall.

Figure 4 shows the important steps in a systemic safety approach. The information in this section is from the *Systemic Safety Project Selection Tool*.[7] The first step is the same type of analysis described in the section on contributing factors analysis. In this step, the Tribal government identifies focus crash types, facility types, and risk factors based on contributing factors analyses. Next, candidate locations are screened based on the focus crash types and presence of risk factors to identify sites that offer the greatest opportunities to improve safety in a particular focus area. From this point, systemic and spot-location processes are essentially the same, with analysts focusing statewide at a program-level instead of looking only at individual implementations of countermeasures.

[7] Preston, H., Storm, R., Bennett, J. D., & Wemple, B. (2013, July). *Systemic safety project selection tool* (Report No. FHWA-SA-13-019). Federal Highway Administration. https://safety.fhwa.dot.gov/systemic/fhwasa13019/sspst.pdf

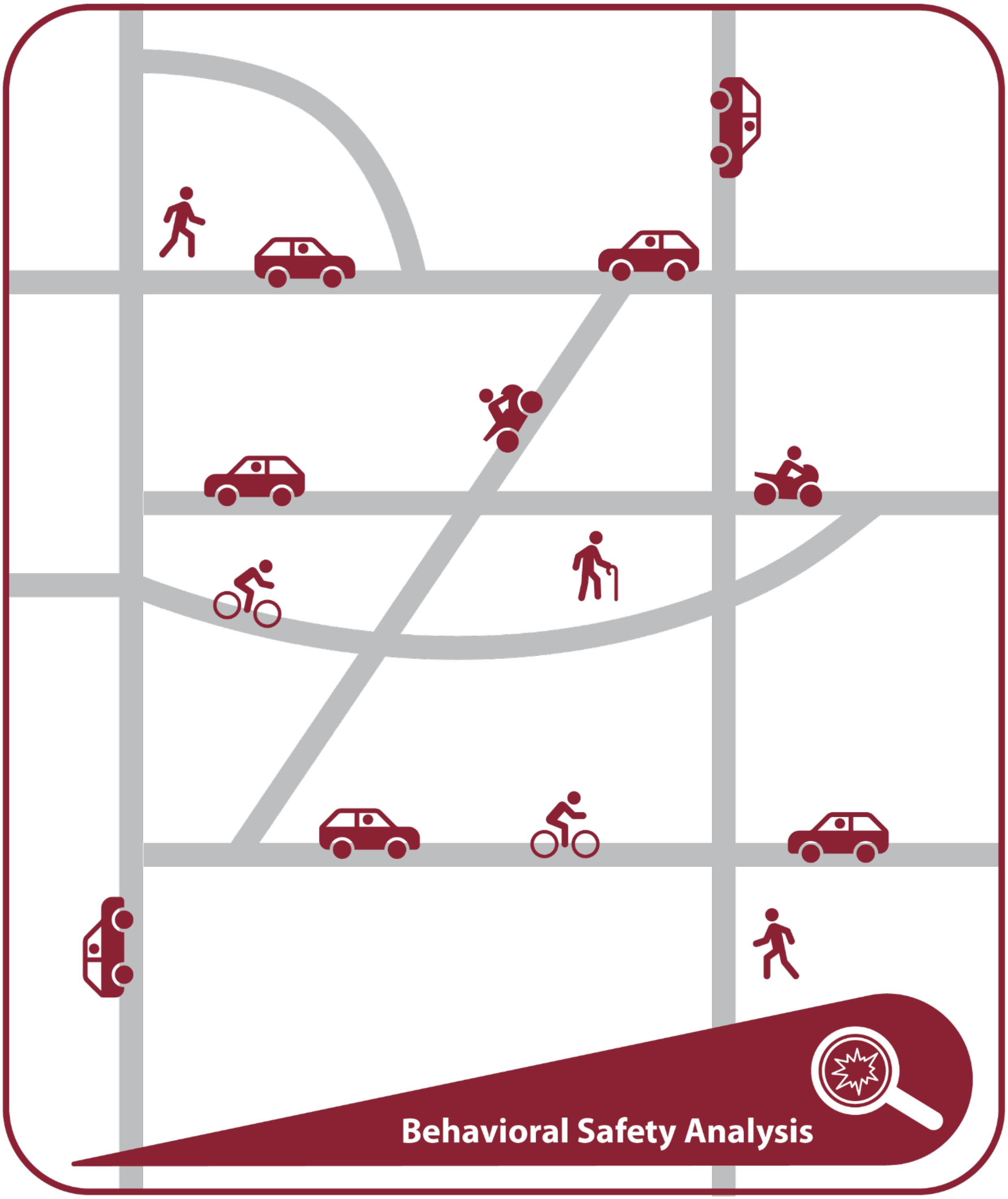
Figure 4. Systemic Safety Analysis Process

The systemic approach can be particularly useful when safety issues are related to roadway features (such as narrow shoulders) that may contribute to crashes wherever they are present. A systemic analysis can justify implementing countermeasures even at locations where crash data are lacking because the analysis shows the type of locations implicated in crashes in general (e.g., curved segments of two-lane rural roads with narrow shoulders). The systemic approach can support treating locations if the Tribe wants to reduce the likelihood of a particularly serious type of crash, for example, the Tribe's crash data shows 55 percent of serious crashes are caused by road departure and most of these crashes are occurring on roads with a paved shoulder less than 1-ft wide.

Overall Roadway Safety Management

Tribes may wish to combine systemic and location-specific approaches. The most effective way to combine the approaches is to identify projects based on both approaches and prioritize the projects based on the Tribe's chosen economic or effectiveness evaluation. This could be a B/C analysis, or some other choice that best reflects the Tribe's priorities. Tribes in rural areas may find that the network screening approach yields few or no discernable "high crash" or "high potential for safety improvement" sites due to low traffic exposure and this could lead to the decision to pursue a systemic approach. Another option is to seek funding for each approach. Tribes may also decide that systemic approaches work best for low-cost solutions that can be applied to many locations in a short time frame. That would allow the Tribe to allocate funding in a way that would generally address a problem on the systemic level while still reserving some funds for more costly countermeasure implementations at selected spot locations. With limited funding, systemic approaches may stretch the money further (over more locations) compared to implementing more expensive treatments at a small number (or only one) site per year.

The last step—evaluation—is key for long-term success. Evaluation of location-specific treatments tells the Tribe how well its selected countermeasures perform. The results of past implementations help the Tribe decide which countermeasures work best, in their experience, and help to adjust expectations whenever the same countermeasures are used again. Evaluating systemic safety improvements is also important. The results of a systemic safety program evaluation tell the Tribe if lower-cost implementations deliver the desired safety improvements throughout the entire jurisdiction. The Tribe can use the evaluation results to determine how best to balance spending on location-specific and systemic approaches in the future.


Behavioral Safety Analysis

Behavioral Safety Analysis

The term behavioral safety analysis is used to distinguish the approaches that deal with road users and their interaction with the roadways from the engineering approaches (aimed at implementing infrastructure improvements). For most of the behavioral safety programs, there are both behavioral and engineering countermeasures that could be implemented. There is a third type of analysis—focused on vehicles' safety features—that could be dealt with separately; however, this is usually only relevant at a national level. This section includes some vehicle-related safety analyses that generally relate to the drivers' and other users' safety and don't focus on the conditions or features of the vehicles. Because Tribal lands often have high truck volumes on some of the roadways, this section includes some considerations related to large truck safety.

Safety Programs

NHTSA defines several safety program areas related to road users, behavior, and crash experience. Program areas are similar to a list of safety focus areas that might be included in a strategic highway safety plan, or the Tribe's TSP. They identify areas where a Tribe may want to use resources to address a specific set of problems and contributing factors. These important focus areas include the following drawn from the NHTSA website (www.nhtsa.gov). Links to each program are provided in the Appendix.

- Occupant protection
- Impaired driving
- Younger drivers
- Older drivers
- Pedestrians
- Pedalcyclists
- Distracted driving
- Drowsy driving
- Speeding
- Motorcyclists

Steps in behavioral safety program management

The safety analysis is similar among all program areas; therefore, this tool does not include examples of all such analyses. However, the descriptions in this section apply well to all.

The typical steps in behavioral program analysis are similar to those for roadway analysis, and include:

- Problem identification,
- Countermeasure selection,
- Prioritization,
- Program development and implementation, and
- Evaluation.

Problem identification is the same as the contributing factors analysis described earlier in this document. It uses crash data (and other resources as needed) to find the most prevalent contributing factors and sub-population groups in crashes. The scope of the problem is quantified as the number of crashes, number of injuries, and the number of fatalities. The focus is on behavior and condition of the people involved in crashes.

For example, an occupant protection problem identification might start with an observational study to estimate the percent belt use by front-seat occupants. The analysis would also look at crash data to examine injury levels and percent belt use for occupants of motor vehicles in crashes. In a Tribal government analysis, it might be important to look at whether unbelted people, and unbelted crash victims in particular, live nearby or are people who are traveling through the Tribal lands. These data sources would give decision makers a better understanding of the problem and that understanding helps to better focus improvement efforts.

Problem identification in behavioral analyses often looks at sub-groups of people and areas within a jurisdiction where risk is highest. For example, in occupant protection, the analysis might find that males are more likely than females to be unbelted and that they may also account for more of the injuries and fatalities associated with being unbelted. The analysis might also examine the areas within the Tribal jurisdiction with the lowest belt use rates.

Countermeasure selection is typically performed by the safety program manager (the person in charge of safety overall or safety in a specific program area like occupant protection). This step involves finding effective ways to address the problems identified. These decisions rely on experience with attempts at safety improvement, available support from State and national programs, and research on behavioral countermeasures' effectiveness. One key resource is NHTSA's *Countermeasures That Work*.[8] That document gives decision makers a good sense of which countermeasures most reliably deliver the desired safety improvements.

For example, in the young driver safety area, *Countermeasures That Work* summarizes research on improving the safety of young drivers and their passengers. It describes research on the effects of graduated driver licensing (GDL), teen driver training, parental involvement, and law enforcement. Countermeasures that have been studied extensively, like GDL, include an estimate of the percentage reduction in crashes when that countermeasure is implemented. Others, like parental involvement programs, have less certain research support and an estimate of the percent effectiveness may not be included. Safety decision makers in Tribal government can select from among the countermeasures described in the report or may choose to develop their own countermeasures.

Prioritization involves deciding which countermeasures to include in a safety program. Tribal governments have two basic priorities to set: (1) safety areas in which to invest; and (2) which countermeasures to implement within each safety area. It is not always possible to conduct a B/C analysis as might be done for roadway safety analyses. In the behavioral area, it is nearly impossible to accurately estimate the benefits (effectiveness) of every proposed countermeasure. Priorities must sometimes be based on the decision maker's sense of how large of an improvement in safety to expect. In such cases, it is a good idea to adjust expectations based on evaluation. As with economic appraisal in the roadway safety analyses, Tribal governments may

[8] Richard et al., 2018.

choose different methods of comparing the expected impact of safety countermeasures than the B/C ratio. The choice should reflect the Tribal government's priorities.

Program development and implementation is the process of designing and delivering safety projects in the context of an overall program aimed at improving safety. Once the Tribal government sets its safety priorities, the program managers can decide how to spend available money on specific projects. Implementation is more than merely putting the program in place. The participating agencies will need to meet eligibility and reporting requirements for any grant-funded projects.

Evaluation is the last step in the process. Ideally, an evaluation will show the benefits of the safety program's projects based on reductions in crashes, injuries, and fatalities. The most compelling results will be based on a before-/after-study comparing baseline crashes (before) to the crashes after the countermeasures are in place. Long-term evaluations can take several years to show the lasting effects of a countermeasure. Tribal governments can conduct their own evaluations by building the costs of needed data collection into the program planning. They may also participate in statewide evaluations by working with the SHSO.

Maximizing benefits of behavioral safety programs

The Tribal government may have its own justice system. It may also have access to funds, as well as the authority, to design and conduct safety programs specifically for Tribal safety improvement. Tribal governments often work with non-Tribal agencies operating in overlapping jurisdictions. The opportunity exists to use safety program grants through the State and Federal governments for safety improvements on Tribal lands.

The Tribal justice system can develop their own countermeasures aimed at improving safety through behavioral change. The opportunity to create and manage unique safety programs is exciting; however, it can be difficult to convince a grant-providing agency to fund a countermeasure that hasn't been tried before.

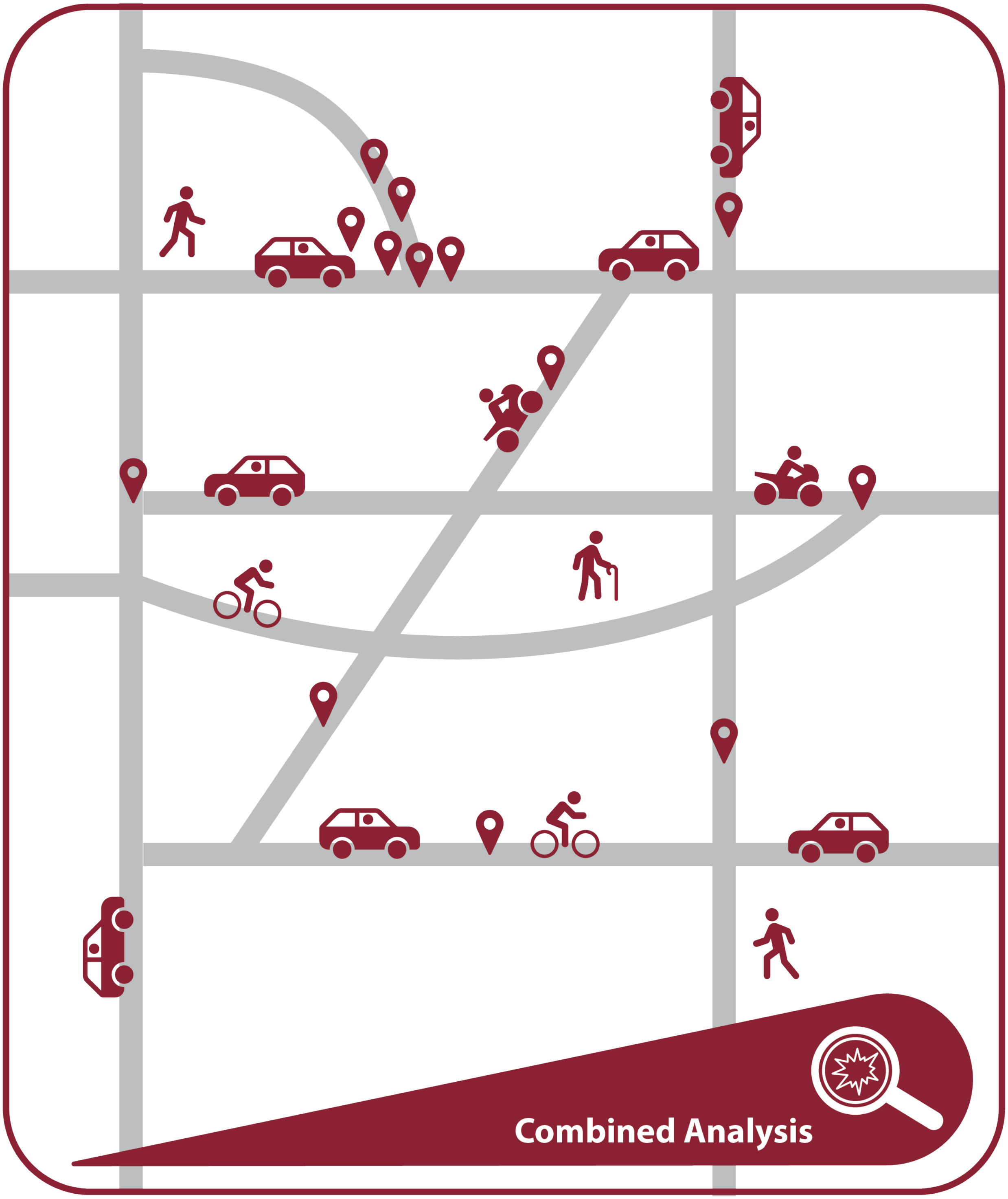
A long-term viewpoint is beneficial. If the Tribal government wants to try its own, unique safety countermeasures, committing to evaluation is a good practice. That will help the Tribe develop a sense of how well each countermeasure works. It can use that information to plan in the future.

Coordinated Programs

Safety offices, healthcare providers, and law enforcement agencies may be interested in participating in coordinated safety programs and evaluations with State, local, and Federal partners. There are several examples; however, a few may be of particular interest to the Tribal government. These include:

- **Child Passenger Safety Technician:** CPSTs are trained in how to inspect and install child safety seats and booster seats. Some programs provide seats at low or no cost to recipients. NHTSA encourages first responders (law enforcement, fire, and EMS) to become certified. This is not necessarily aimed at enforcing existing laws, but rather to spread knowledge and awareness of the benefits of putting each child in an appropriate seat and using the seats properly. Training and certification are available. Trained CPSTs can conduct child passenger safety clinics and help drivers protect their young passengers.

- **Seat Belts:** The Bureau of Indian Affairs Office of Justice Services, Indian Highway Safety Program conducts seat belt observation surveys. Each State also conducts an annual seat belt use observation study. The goal is to obtain reliable data on the statewide usage rate. If the State does not already measure seat belt usage rates in Tribal areas, it may be possible to extend or replicate the study locally to get valid data. States also conduct seat belt campaigns, including *Click It or Ticket* education and enforcement waves. Law enforcement in Tribal areas may already be participating in these programs. If they are not, it may be a way to improve safety and get the message out. States often develop coordinated enforcement and messaging campaigns, including public service announcements on the benefits of wearing seat belts.
- **Program Evaluations:** SHSOs periodically evaluate their programs. This may be a formal, NHTSA-sponsored evaluation (such as those for occupant protection, impaired driving, and traffic records) or it may be a special study such as research on the recidivism rate reductions for participants in an ignition interlock device program. Tribes may participate in those evaluations or may choose to do their own.
- **Commercial Motor Vehicle Safety:** States operate the Motor Carrier Safety Assistance Program grant-funded enforcement programs. In Tribal areas with high numbers of large commercial motor vehicles, the MCSAP grants can fund enforcement training and inspections. Interested Tribes should contact the State MCSAP lead agency to obtain support. Tribes are also eligible to apply for funding through FMCSA's high-priority grant. Tribal governments may want to participate in developing commercial vehicle safety plans as well.


Combined Analysis

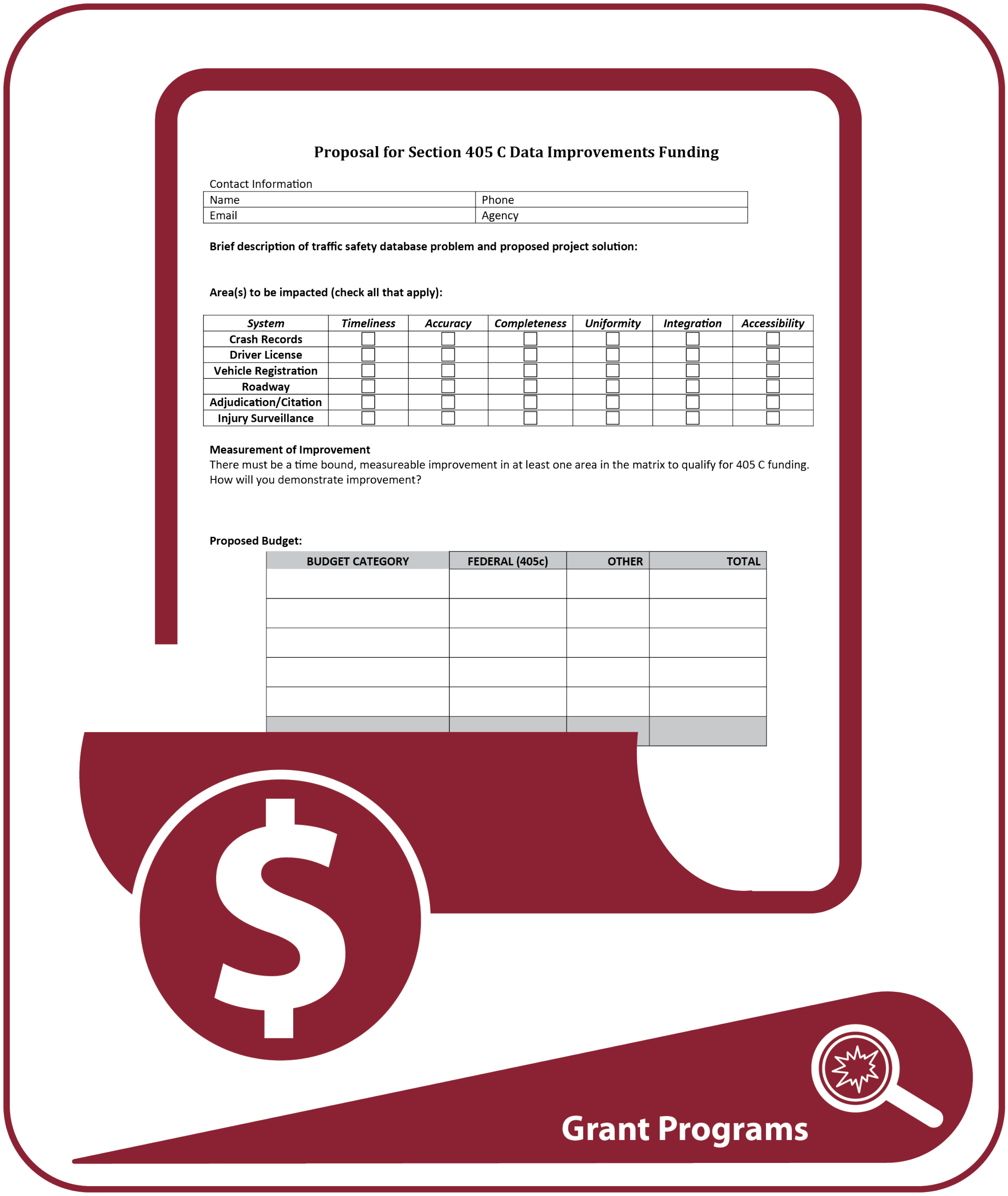
Combined Roadway and Behavioral Safety

Comprehensive approaches to safety improvement combine engineering, EMS, and behavioral safety improvement activities. This is an effective approach because well over 90 percent of crashes include at least one human-related contributing factor and the data shows that including an enforcement component alongside *most* countermeasures helps improve performance. The following are some examples of more comprehensive safety programs that combine the efforts of agencies.

Safe system approach: The safe system approach aims to promote safety for all road users. From a design perspective, the approach advises separating users of different types, especially when there are vulnerable road users in the mix (e.g., pedestrians, pedalcyclists, motorcyclists). When physical separation is not possible, the safe system approach advocates drastically lowering speed limits (often to 30 mph or lower) so that if a crash does occur, it is much less likely to result in serious injury or a fatality. The safe system approach also addresses road user behavior but brings in viewpoints from planning and social justice.

Toward Zero Deaths initiatives: TZD initiatives aim to eliminate all roadway fatalities. Like the safe system approach, TZD initiatives focus on eliminating the chances of a serious crash. Many States have a TZD coalition. The Tribal government may wish to participate in TZD activities. Individual agencies may also participate.

Road Safety Audits: An RSA is a multi-disciplinary examination of a location that has higher-than-expected frequency or severity of crashes. Usually led by the State DOT, an RSA pulls together a team of experts from engineering, law enforcement, EMS, and others. The goal of the group is to examine the crash experience at the site and determine what countermeasures will best address the issues they discover. RSAs may sometimes result in a determination that the most effective solution is a redesign (e.g., replacing an intersection with severe crashes with a roundabout); however, the more common finding is that low-cost infrastructure improvements combined with enforcement and other non-engineering solutions is the most cost-effective approach.



Proposal for Section 405 C Data Improvements Funding

Contact Information

Name	Phone
Email	Agency

Brief description of traffic safety database problem and proposed project solution:

Area(s) to be impacted (check all that apply):

System	*Timeliness*	*Accuracy*	*Completeness*	*Uniformity*	*Integration*	*Accessibility*
Crash Records	☐	☐	☐	☐	☐	☐
Driver License	☐	☐	☐	☐	☐	☐
Vehicle Registration	☐	☐	☐	☐	☐	☐
Roadway	☐	☐	☐	☐	☐	☐
Adjudication/Citation	☐	☐	☐	☐	☐	☐
Injury Surveillance	☐	☐	☐	☐	☐	☐

Measurement of Improvement
There must be a time bound, measureable improvement in at least one area in the matrix to qualify for 405 C funding. How will you demonstrate improvement?

Proposed Budget:

BUDGET CATEGORY	FEDERAL (405c)	OTHER	TOTAL

Grant Programs

This section presents information for Tribes on relevant grants that can be used to improve crash data, other safety data, and safety management processes.

BIA Indian Highway Safety Program

The Highway Safety Act of 1966, U.S.C. Title 23, Section 402, provides U.S. DOT funding to assist Indian tribes in implementing traffic safety projects. These projects are designed to reduce the high number of traffic crashes and their resulting fatalities, injuries, and property damage within Indian communities. The BIA provides and administers the Indian Highway Safety grants to federally recognized tribes. If awarded, funds may be used to addressed behavioral highway safety problems, including enhancing the tribe's current law enforcement or child safety seat programs.

Tribes may obtain further information at the BIA, Office of Justice Services, Division of Highway Safety website (www.bia.gov/bia/ojs/dhs) or by contacting:

BIA OJS Indian Highway Safety Program
1001 Indian School Road, NW
Albuquerque, NM 87104

Main phone: 505/563-3764
Fax: 505/563-5375
ojs_indian_highway_safety@bia.gov

NHTSA 405(c) Traffic Records Improvement Grants

NHTSA's 405(c) Safety Data Improvement grant program can be used for crash system improvements. States are eligible for these grants. Tribes may be eligible to receive grant money under this program as a subrecipient of the SHSO.

NHTSA GO Teams - Traffic Records Technical Assistance

NHTSA offers free technical assistance from a contractor for Tribes and States to improve traffic safety data. GO Teams consist of 1-3 subject matter experts who are selected based on the specific traffic safety needs of the Tribe. GO Teams recommend strategies, methods, and tools that Tribes can use to overcome their traffic safety challenges. Examples of possible GO Teams for Tribes include such tasks as:

- Improving crash data collection;
- Identifying crash data analysis problems;
- Developing data sharing agreements; and
- Working on strategic planning with the State Traffic Records Coordinating Committees.

Tribal nations can apply for GO Team (www.tribalsafety.org/data-collection) technical assistance.

FHWA Tribal Transportation Program

The FHWA Office of Tribal Transportation manages the Tribal Transportation Program Safety Fund for all Federally recognized Tribes. Each year TTP funds are set aside to address transportation safety issues in Native America. Funds are available to Federally recognized Indian tribes through a competitive, discretionary program. Crash data assessment, improvement, and analysis are eligible projects for the TTP Safety Fund. A complete application should consist of:

- Completed online application;
- Project narrative;
- Supporting incident data;
- Supporting safety plan; and
- Any other applicable supporting documentations.

FHWA Highway Safety Improvement Program

The Highway Safety Improvement Program is a core Federal aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on Tribal land. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads with a focus on performance. HSIP funds may be used to improve crash data. The application process varies by State, and Tribes should contact their State DOT for further information.

FHWA Tribal Technical Assistance Program

The TTAP was created to provide technical assistance to Tribal governments in administration of their transportation programs. Contact FHWA's Office of Innovative Program Delivery's Center for Local Aid Support to determine what training and technical assistance may be available.

Summary and Conclusions

This tool is part of the Tribal Crash Reporting Toolkit. The tools include: Crash Data Facts and Fiction Information, Data Analysis (this tool), Toolkit Manual, Crash Reporting, Crash Instruction, Quality Control, and Database. The tools can be used individually (this data analysis tool does not require use of any of the other tools, for example). Tribes are free to select those tools that are most helpful to them.

The data analysis tool is designed to provide an overview of how Tribes manage safety using a data-driven approach. The tool uses examples from several Tribes' strategic TSPs. Those examples present a good starting point that shows how Tribes are using analyses of crash types and contributing factors to identify safety focus areas.

The data analysis tool also provides an overview of state-of-the-practice safety management processes. It includes descriptions of location-specific roadway analyses like those in the *Highway Safety Manual.* It also explains the systemic approach to roadway safety which is more typical of the approaches used in the Tribal TSP. For behavioral safety programs, the data analysis tool presents recommended practices and guidance from NHTSA and, again, references analyses found in Tribal TSPs. All the methods include a step that is based on the contributing factors analysis presented at the start of this tool. The technique is generally applicable, and Tribes can use the same method in analyses to support their safety improvement planning.

The analysis tool ends with a section on funding sources that Tribes may wish to access. Finally, the appendix provides a list of useful links related to safety management processes, TSPs, analytic resources, and funding sources.

Appendix of Links

Native American Traffic Safety Facts:

https://cdan.nhtsa.gov/NA_report/NA_Report.htm#

Tribal Transportation Safety:

www.tribalsafety.org/
https://flh.fhwa.dot.gov/programs/ttp/
https://flh.fhwa.dot.gov/programs/ttp/safety/plans.htm
https://flh.fhwa.dot.gov/programs/ttp/safety/ttpsf.htm

Helpful Links for Roadway Safety Analysis:

www.highwaysafetymanual.org/Pages/default.aspx
https://safety.fhwa.dot.gov/rsdp/
https://safety.fhwa.dot.gov/systemic/
www.cmfclearinghouse.org/

Helpful Links for Behavioral Analysis:

www.ghsa.org/resources/countermeasures
www.nhtsa.gov/risky-driving/seat-belts
www.nhtsa.gov/equipment/car-seats-and-booster-seats#35091
www.nhtsa.gov/risky-driving/drug-impaired-driving
www.nhtsa.gov/risky-driving/drunk-driving
www.nhtsa.gov/road-safety/teen-driving
www.nhtsa.gov/road-safety/older-drivers
www.nhtsa.gov/road-safety/pedestrian-safety
www.nhtsa.gov/road-safety/bicycle-safety
www.nhtsa.gov/risky-driving/distracted-driving
www.nhtsa.gov/risky-driving/drowsy-driving
www.nhtsa.gov/risky-driving/speeding
www.nhtsa.gov/road-safety/motorcycle-safety

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U.S. Department
of Transportation

National Highway
Traffic Safety
Administration

NHTSA

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