5 Ways to

VISUALIZE ROAD CRASH RISKS

and Mitigate Them

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Save Time. Save Money. **Save Lives.**

5 Ways to **VISUALIZE ROAD CRASH RISKS** and Mitigate Them

Road crashes are a major cause of death and serious injuries worldwide. This fact poses a huge **challenge for transportation agencies**: how to **minimize crash risks and save lives**.

Reducing risks requires first identifying the most critical contributing factors and then selecting the most appropriate actions to address them with the available budget.

Fortunately, most agencies have access to a wealth of crash data, both from internal sources and from local law enforcement and emergency medical services. With proper analysis of this data and communication of the findings, transportation leaders can **make the most appropriate decisions** to address the crash risks in their network.

Storytelling with Data

This ebook shows just some of the ways transportation leaders can **use visualizations to help tell the story of road safety risks and communicate the need for countermeasures**. By illustrating crash data in a clear and comprehensive way, visualizations can give decision-makers the information they need to create safety improvement strategies that save lives.

1 US Department of Transportation, National Highway Traffic Safety Administration (NHTSA), 2018.

Using
red light cameras
can **reduce injury crashes at intersections** by
13%–29%[2]

2 Insurance Institute for Highway Safety (IIHS) and Highway Loss Data Institute (HLDI), Red Light Running, 2019.

Common Road Crash Risks

What causes a car crash? Human, vehicle, roadway, and other factors can play a part.

Click on each factor to learn more.

- **Impaired driving**
- **Speeding**
- **Distracted driving**
- **Driver fatigue**
- **Unsafe roadway conditions**
- **Hazardous terrain**
- **Vehical malfunctions**
- **Driver errors**

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The selection of optimal countermeasures is key to an effective safety strategy.

Safety Science Overload

The sheer abundance of government data can make it challenging to discern the most relevant facts for an agency's network. For example, the US Department of Transportation provides online resources for computing the effectiveness of about 7,000 countermeasures designed to reduce the frequency or severity of crashes. Selecting countermeasures “manually” by searching through hundreds of options would tax an agency’s time and resources. Having a robust safety management system that supports the selection of optimal countermeasures is key to implementing an efficient and effective safety strategy.

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Reducing Crash Risks

To reduce crash rates, transportation agencies need to pinpoint the most critical risk factors and take actions to mitigate them.

Data analysis is critical to identifying both the main risk factors and the best strategies to address them. Ideally, agencies can apply both historical and forward-looking analytics to identify risk patterns in past crash data as well as predict future crash rates, given the network's traffic levels.

The US Department of Transportation's **Crash Modification Factors Clearinghouse** provides a wealth of online resources to help agencies worldwide follow best practices for using predictive analytics and selecting countermeasures.[3] However, **the complexity of safety data science can be overwhelming for agencies that still use spreadsheet-based analytical methods.** An advanced safety management software solution such as **AgileAssets® Safety Analyst™** can support simple to highly complex data analysis and the selection of targeted mitigation strategies.

The clearer and more comprehensive the analysis, the better the decision-making. Using visualizations of multiple analyses from the same corridor or network, transportation leaders can pinpoint the greatest risks and evaluate the best actions to mitigate them.

3 In addition, AASHTO's Highway Safety Manual and the World Road Association's Road Safety Manual provide industry-standard frameworks for road safety management.

⚠ Pinpoint critical risk factors

1. Consolidate crash data
2. Screen the network for hotspots
3. Diagnose deficiencies

Take actions to mitigate risks

1. Identify potential countermeasures
2. Select the right countermeasures
3. Implement improvements

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Crash Data Visualizations

5 Examples Based on an Analysis of a US State Road Network

The graphics on the following pages illustrate just some of the ways safety engineers can choose to **display and communicate information about the most critical crash risk factors** in a given corridor or road network.

The five types of visualizations in this ebook represent findings from an actual road network safety analysis performed by a major US state department of transportation using the **AgileAssets® Safety Analyst™** software solution. This solution helps agencies store, manage, retrieve, and analyze complex safety data so that stakeholders can pinpoint the **most critical risks** in their road network and select the most appropriate **countermeasures**. Agencies can export data from the AgileAssets solution and use third-party visualization tools to create reports and presentations that help tell a compelling story of their network's safety performance.

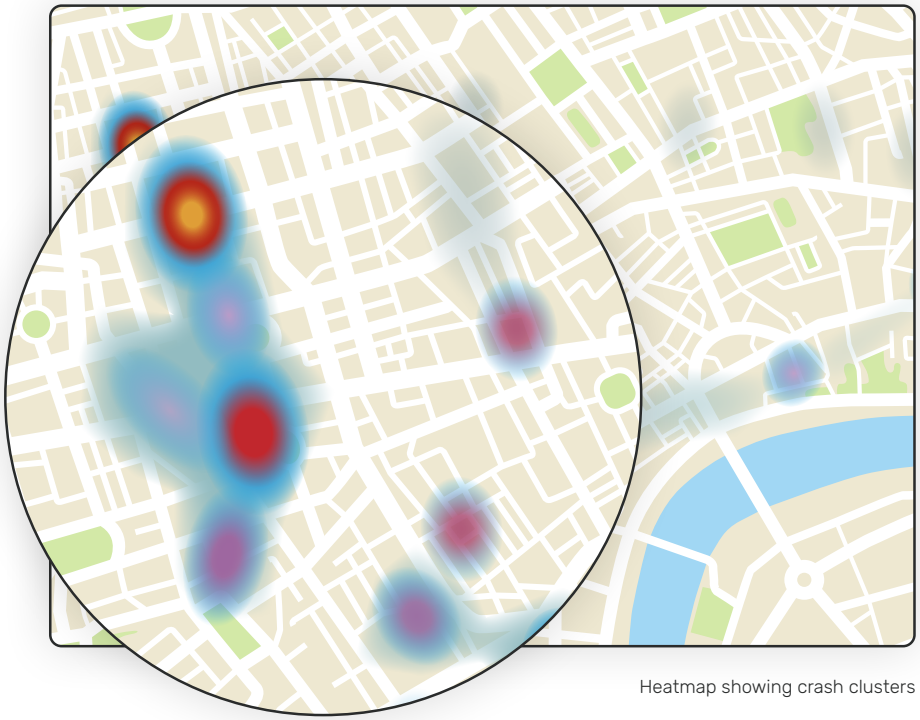
For illustration purposes, we have simplified and modified the visualizations in this ebook to protect actual agency data. Although each visualization may display a multitude of findings (risk factors), we highlight just one or two key findings from each graphic. For each key finding, we identify safety management tips to consider when developing a risk mitigation strategy.

4 Together for Safer Roads, Investing in Road Safety, 2015.

1 Heatmap

Heatmaps are an excellent tool for using spatial data to display location-specific crash rates and risk levels. The heatmap to the right highlights locations where the most crashes occur.

The red-and-yellow hotspots indicate the places with the highest crash rates. The map helps safety engineers prioritize the most risk-prone geographic areas and identify where to focus their efforts.



Heatmap showing crash clusters

Safety Management Tip

A heatmap is most effective when it highlights the locations where crash rates are higher than the predicted rate for the given type of road and traffic volume. Be sure to compare actual crash rates over a year's time with the expected rates for the given stretch of road, based on average annual daily traffic (AADT). If crash rates are lower than expected, redirect safety efforts to those geographic areas where crash rates consistently exceed predictions. Use additional visualizations such as those illustrated in this ebook to support a deeper evaluation of the locations with higher-than-normal crash rates. Then you can focus your mitigation investments on the areas where they can make the biggest impact.

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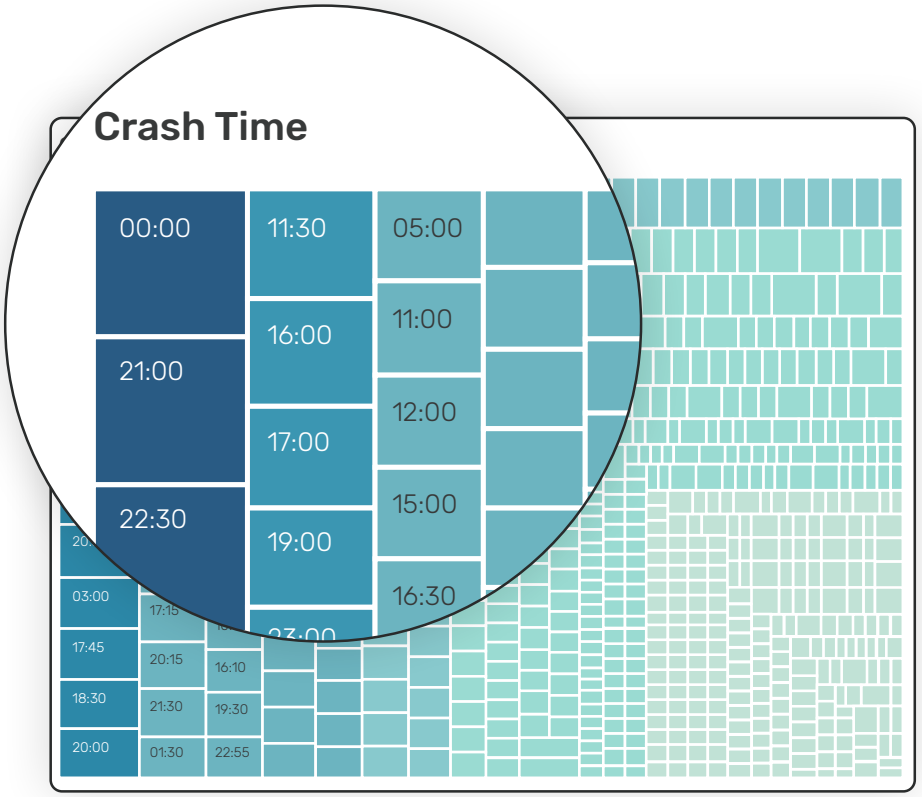

Mosaic chart showing crashes by time of day

2 Mosaic Chart

A mosaic chart is an effective way to display findings from an analysis of several risk factors. The chart to the left uses size, position, and color of the shaded areas to reflect variations in crash frequency, time of day, and day of the week when crashes occurred.

The bigger the rectangle and the darker the blue, the higher the crash frequency. Columns on the left side of the graph indicate weekend days. The combined data on this graph shows that the most frequent crashes occur late at night on weekends. Transportation leaders might recommend heightened law enforcement during the times with the highest crash rates.

Safety Management Tip

While crash times might shed light on driver behavior, a more reliable analysis of crash risks would take into account additional data such as actual vs. predicted annual crash rates for a given stretch of roadway, any hazardous conditions that might exist, and reported contributing factors such as impaired driving.

If crash rates are higher than average (as displayed on a heatmap) and impaired driving is a predominant cause (as reported by law enforcement), a mitigation strategy might include implemeting sobriety checkpoints near the highest-risk locations on the days of the week and in the time frames with the highest crash rates.

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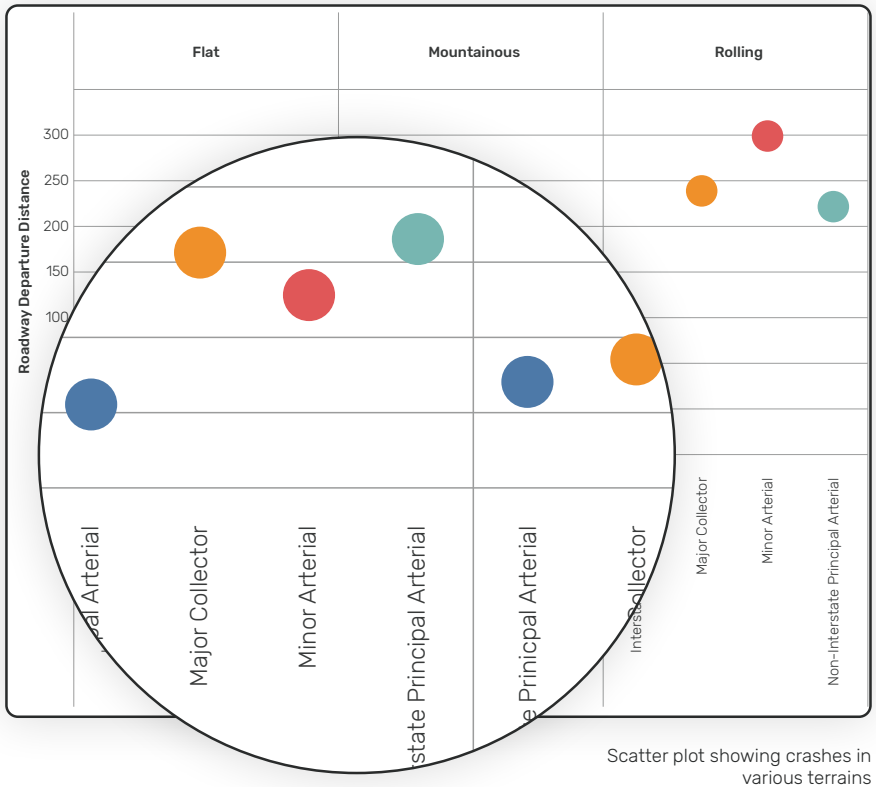
3 Scatter Plot

A scatter plot is useful to show data on two or three risk factors using points that may vary by color and size according to their values. The scatter plot to the right displays data on roadway type, departure distance, and type of terrain.

The graph shows that the most severe roadway departures occur in rolling terrain, so transportation leaders would likely prioritize countermeasures there vs. in the other landscapes. A cost-effective countermeasure is signage that draws attention to hidden hazards. Other possible countermeasures might include signals or runaway truck ramps on the most crash-prone stretches of road.



Scatter plot showing crashes in various terrains

Safety Management Tip

To validate the hypothesis that rolling terrain presents the greatest crash risk, calculate the expected crash rates based on multiple criteria—for example, terrain, roadway type, and shoulder width. Create a heatmap showing the locations with above-average crash rates for each of the combined criteria. Conduct a deeper analysis on the locations with the highest above-average rates. Compare the benefits and costs of potential countermeasures—e.g. signs, signals, ramps—to identify the best feasible option.

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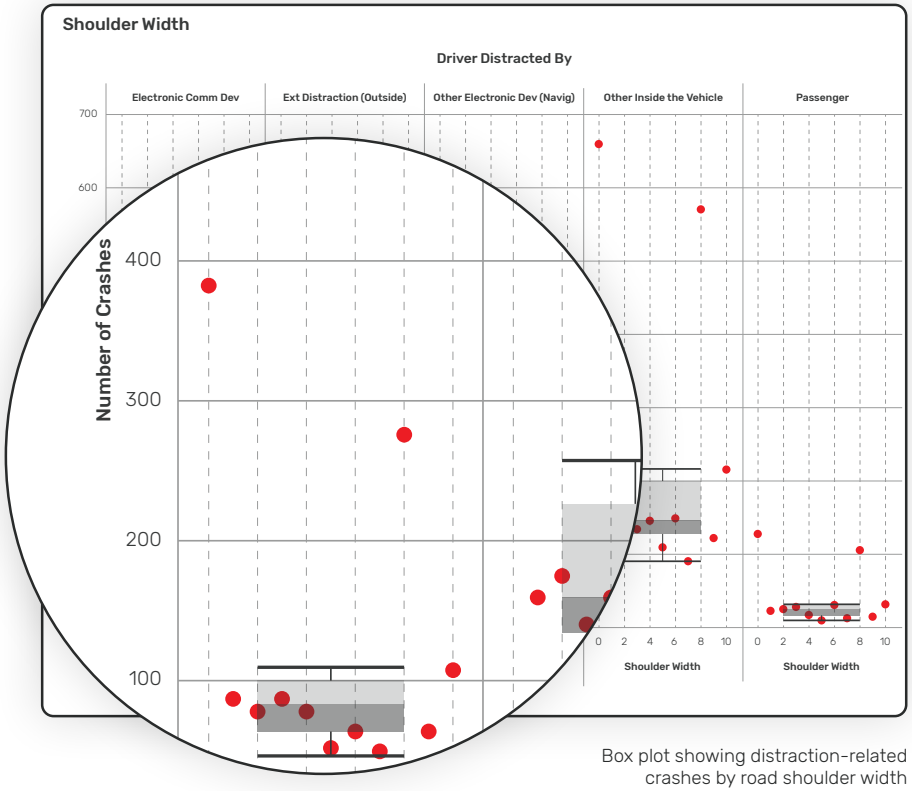

Box plot showing distraction-related crashes by road shoulder width

4 Box Plot

The box plot is helpful to display crash-risk data that spans a range of values (from minimum to maximum, with interim ranges highlighted in between). The box plot to the left helps show how distraction-related crash rates vary by roadway shoulder width and by type of driver distraction.

The graph shows that most crashes occur where the shoulder width is narrow, so mitigation strategies might include shoulder widening.

Safety Management Tip

Narrow shoulder width is a well-known risk factor for roadway-departure crashes. To validate shoulder-width crash data, it is important to compare actual crash rates with the expected annual crash rates based on average annual daily traffic (AADT). Because shoulder widening is a relatively high-cost countermeasure, safety managers should compare the benefit-cost ratios of related interventions such as installing narrow-shoulder warning signs or rumble strips near the locations with the highest above-average crash rates.

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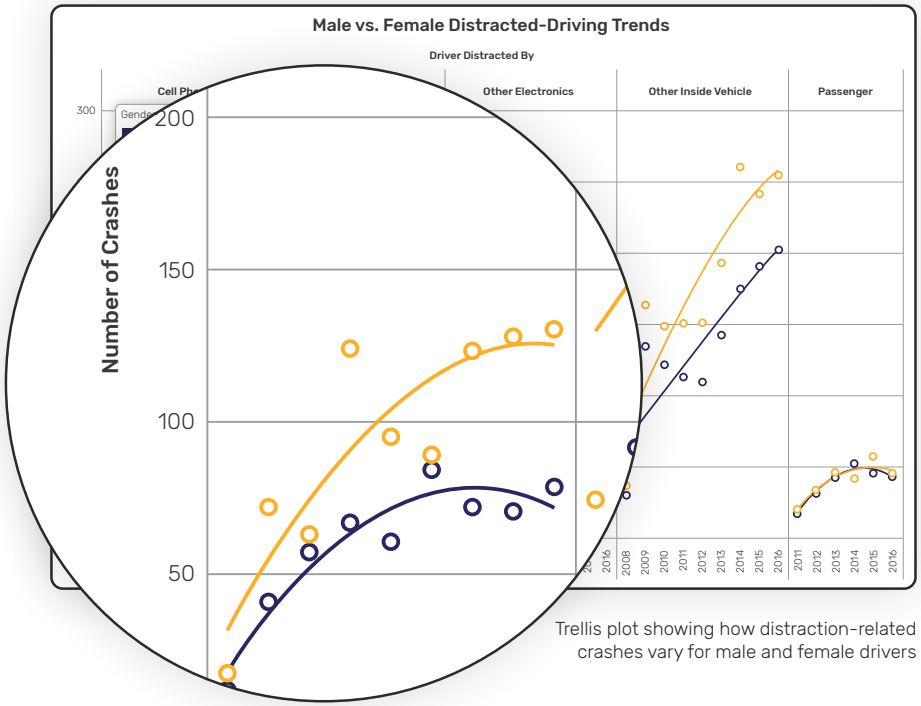
5 Trellis Plot

Here is the first of two examples of a trellis plot graph. Each shows how multiple crash-risk factors correlate to one another.

The visualization to the right contains side-by-side scatter-line graphs to facilitate a comparison of crash rates by type of driver distraction and by gender of the driver. Because the data shows males have higher crash rates, transportation leaders might support education campaigns for that demographic.



Trellis plot showing how distraction-related crashes vary for male and female drivers

Safety Management Tip

A targeted public-awareness initiative can be an effective way to educate drivers about behavior-related safety risks. To identify populations that can benefit most from educational campaigns, combine several types of demographic analysis—for example, gender, age, and type of risky behavior. Then deliver suitable messages through the most relevant communication platforms for that demographic—such as variable message signs, social media, public-service announcements, or community events.

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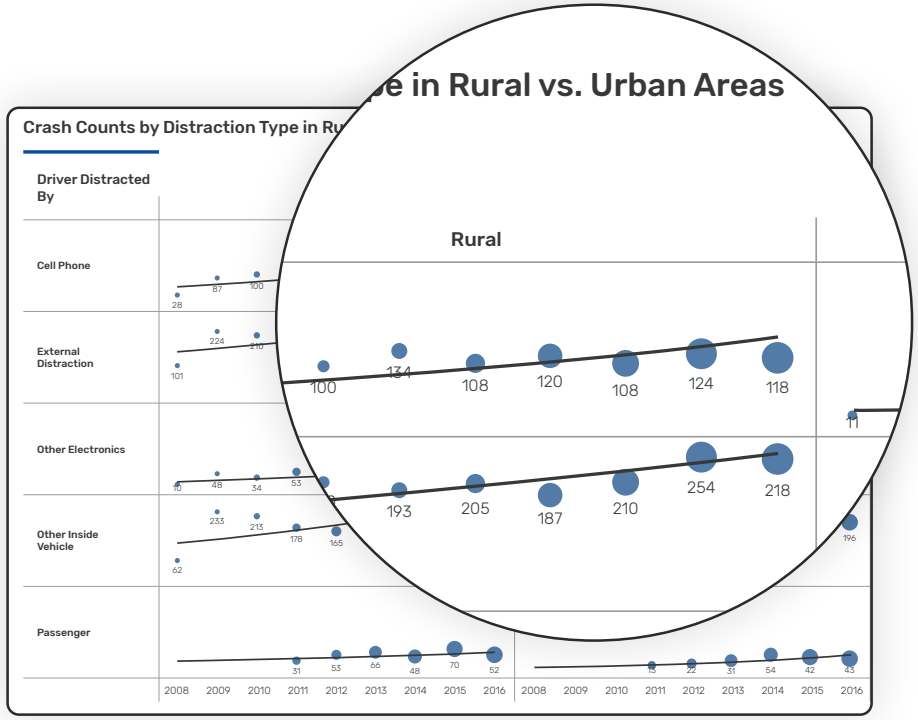

Trellis plot showing how distraction-related crashes vary in urban and rural areas

5 Trellis Plot (cont.)

Here is the second of two examples of a trellis plot graph. Each shows how multiple crash-risk factors correlate to one another.

This visualization includes multiple scatter-line graphs to show the differences between rural and urban crash rates for various types of distraction-related crashes. The lower rate of cell phone-related crashes in urban areas might signal to decision-makers that existing cell phone bans are effective.

Safety Management Tip

Law enforcement measures, combined with effective roadway engineering strategies, can reinforce safe driving behavior. Traffic laws should reflect local roadway conditions and align with national safety standards. Many jurisdictions encourage compliance with traffic laws through friendly, catchy slogans that appeal to common sense and driver accountability—e.g. "Hey Texas, buckle up! Thanks, y'all" or "Text later—it can wait."

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Better Decision-Making to Save Lives

Improving road safety is a complex challenge that requires advanced data analysis to identify crash risk factors and optimal mitigation strategies. The more clear and comprehensive the analysis, the more effective can be the decisions about which strategies to pursue.

Using data visualizations to communicate analytical findings can help transportation leaders tell the story of the network's road safety risk factors and recommended countermeasures. Pinpointing the most critical risks helps decision-makers choose the best strategies to address them—and save more lives.

> Visualizations can help tell the story of the network's most critical road safety risks and the best strategies to address them.

5 World Health Organization, Road Traffic Injuries, 2018.

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LEARN MORE

Find more information about safety management strategies and solutions at **AgileAssets.com**.

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Save Time. Save Money. **Save Lives.**

Thank you for reading.

Find more crash-risk statistics below.

Impaired driving

Close

Sobriety checkpoints
can reduce
alcohol-related
crashes by
17% or more*

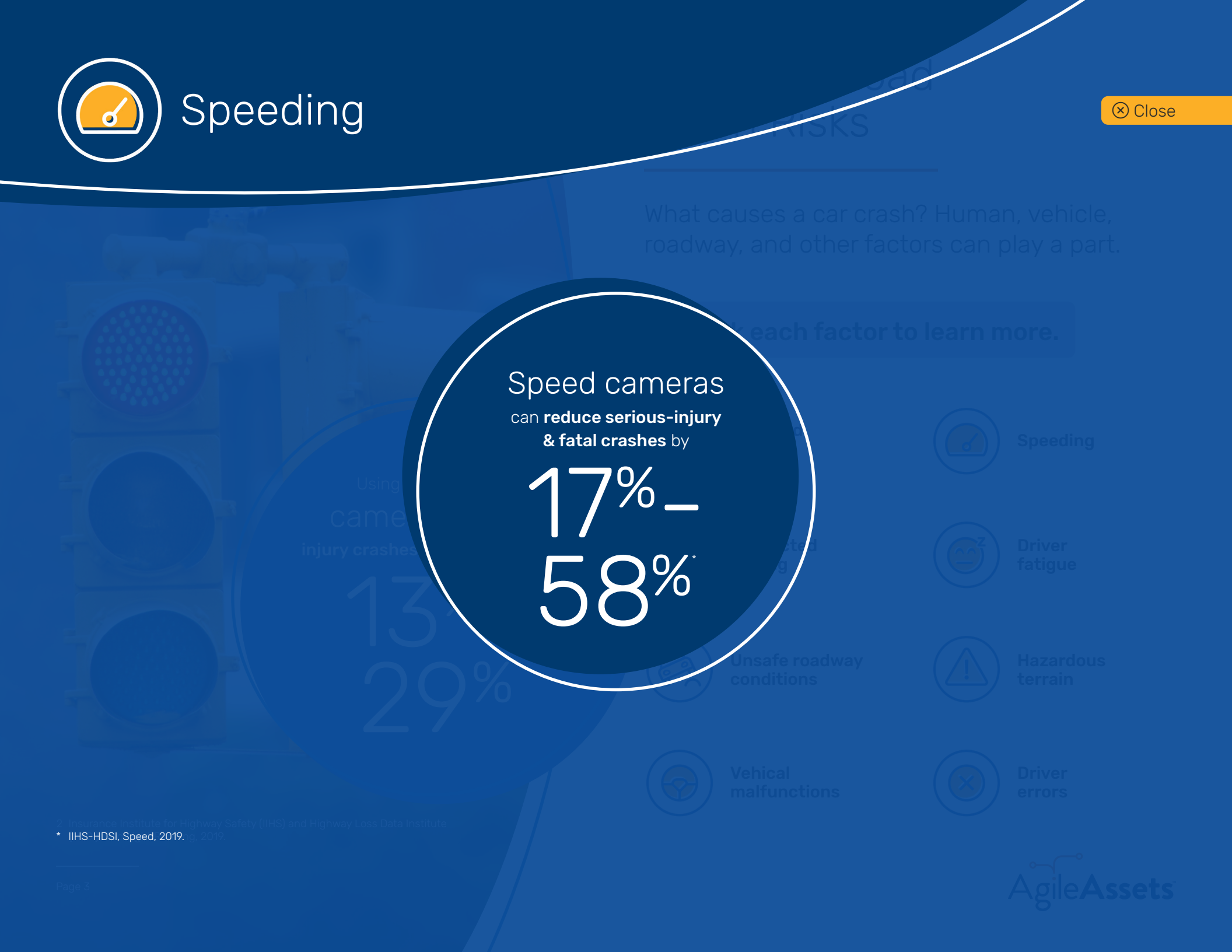
* IIHS-HSDI, Alcohol and Drugs, 2019.

Speeding

Close

Speed cameras can **reduce serious-injury & fatal crashes** by

17%–58%*



* IIHS-HDSI, Speed, 2019.

Distracted driving

Close

Drivers using cell phones are

400%

more likely to **have a crash***

* World Health Organization, Road Traffic Injuries, 2018.

Driver fatigue

Close

Rumble strips

can reduce by

50%

the rate of

roadway departure crashes—the most frequent types of crashes by

drowsy drivers*

* NHTSA, as cited by the US Department of Transportation, Federal Highway Administration (FHWA), 2017.

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Unsafe roadway conditions

Close

De-icing pays for itself through reduced crash rates in less than

30 minutes

after winter road maintenance*

* Safe Winter Roads, 2019, as cited in Driving Tests, The Ultimate List of Driving Statistics for 2019.

Hazardous terrain

Close

Raised pavement markers

in high-accident locations have been shown to **reduce injury crashes** by

15%

and yield a

6.5:1

benefit-cost ratio*

* Oregon Department of Transportation, Risk Factors Associated with High Potential for Serious Crashes {Final Report SPR 771], 2015.

Vehicle malfunctions

Close

Side airbags
can
reduce driver deaths
by nearly
40%*

* IIHS, 2019.

Driver errors

Close

Driver
performance errors
increase crash risks
by more than
1,000%*

* Virginia Tech Transportation Institute, 2016.