U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

Incorporating Safety in to Project Purpose and Need

Agency Guidance Review

Themes featured in this case study:

- ✓ Safety in Pre-NEPA Studies
- ✓ Noteworthy Documentation Practices
- ✓ Safety in Project Purpose and Need
- ✓ Substantive Safety Analysis in NEPA

Introduction

There has been substantial effort by agencies to assess safety performance when developing transportation infrastructure projects. Advancing safety data collection and analysis through research, practice, and policy with national safety goals has been essential in this effort. Several State departments of transportation (DOTs) throughout the United States have sought to develop and institutionalize guidance and methods for analyzing safety performance during the National Environmental Policy Act (NEPA) reviews of highway projects.

The Federal Highway Administration's (FHWA's) *Integrating Road Safety into NEPA Analysis* primer notes the importance that project purpose and need has on the direction of the NEPA process:

> *"The statement of the project purpose and need is the core component of the NEPA document. It describes the impetus for the project and serves as the benchmark against which project alternatives are evaluated"* (FHWA, 2011; p. 21).

A key challenge when incorporating safety in purpose and need is the degree to which data and analysis support safety as a project need. This approach often fails to consider safety performance analysis and relies on an assumption that meeting design standards alone constitutes a safer alternative:

> *"Safety is often included in the purpose and need statement for a project without sufficient analysis to define the problem. For example, the statement may cite the fact that road features are not up to the most recent design standards as justification that a safety problem exists. Defining the true safety performance of the roadway requires understanding the difference between substantive and nominal safety"* (FHWA, 2011; p. 21).

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Incorporating safety performance analysis into the development of the project purpose and need is critical to adequately determine a safety need and subsequently evaluate project alternatives. In other words, the degree to which a project can satisfy safety as a purpose or need is dependent on the methods and data used to determine that the issue exists.

This case study documents formal guidance developed by three State DOTs and outlines noteworthy practices for incorporating safety as a project need:

- Pennsylvania DOT's (PennDOT's) *Needs Study Handbook*.
- Florida DOT's (FDOT's) *Safety Analysis Guidebook for Project Development and Environment (PD&E) Studies*.
- Ohio DOT's (ODOT's) *Guidance for Developing Purpose and Need*.

Each section presents an overview of each agency's process, its applicability to safety, and a project example that illustrates the guidance in practice.

PennDOT Needs Study Handbook

PennDOT's *Needs Study Handbook* (Handbook) provides guidance to PennDOT staff, planning partners, and consultants for performing and documenting needs assessments associated with transportation improvements (PennDOT, 2020).

Connections to Safety

The Handbook incorporated revisions to PennDOT's project-level safety analyses reflected in recent updates to PennDOT's *Highway Safety Program Guide* (PennDOT, 2021a) and *Pennsylvania Safety Predictive Analysis Methods Manual* (PennDOT, 2021b). The Handbook provides a detailed discussion of how to incorporate safety as a need for transportation projects and recognize the role of safety performance analysis throughout the process. These topics include:

1) Fact-based safety measurement tools such as analysis methods described in the American Association of State Highway and Transportation Officials' (AASHTO's) *Highway Safety Manual* (HSM; AASHTO, 2010) and road safety audits (RSAs).
2) Relationship between safety and other project needs.
3) Iterative approach to addressing safety at each stage of the transportation project development process.

The Handbook emphasizes that it is not enough to, "simply assert that a safety problem exists," in a project's purpose and need, "without also providing data and analysis to demonstrate the safety problem" (PennDOT, 2020, p. 20). Examples of what **not** to do when incorporating safety into the purpose and need are being too broad (i.e., the purpose and need must explain the safety problem) and failing to include supporting data to substantiate the problem.

The Handbook notes the importance of safety data in alternatives analysis:

> *"Having fact-based safety needs is especially important when evaluating project alternatives. Data and analysis must quantify the safety need. The same methodology that defines the safety need for existing and future no-build conditions can also compare the effectiveness of safety improvements among design alternatives such as shoulder width, intersection configuration, etc."* (PennDOT, 2020; p. 20).

The Handbook summarizes key concepts from the HSM and depicts a simplified overview of the HSM analysis process. This overview underscores how crash history can be combined with predictive methods to determine if a safety issue is present. For instance, if a predicted number of crashes weighted by the crash history for a specific site (i.e., expected crashes) exceeds the baseline number of predicted crashes for a "typical," similar facility in the State (i.e., predicted crashes), this can be used as robust evidence for a potential safety issue at that site (figure 1). This would help justify safety as part of the purpose and need for the project.

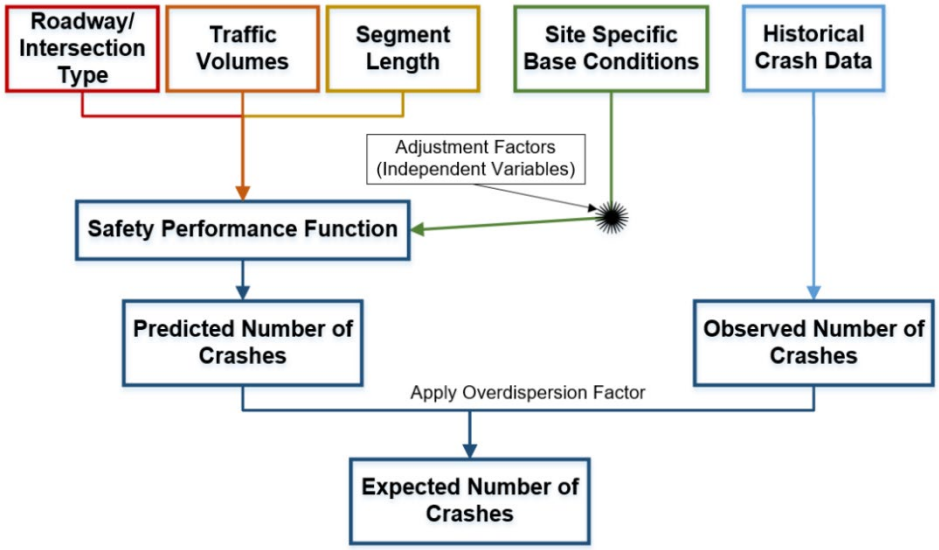

Figure 1. Graphic. Overview of the HSM analysis process as shown in PennDOT's Needs Study Handbook. Source: PennDOT, 2020.

PennDOT has developed spreadsheet tools to assist practitioners with using HSM analysis methods and determine safety as a potential project need (PennDOT, 2022). The tools guide users through the process of inputting relevant project data and analyzing results. The tool creates a project-level safety summary report which summarizes the safety performance (i.e., predicted, observed, and expected average annual crash frequency) of the project. The results can either substantiate or reject safety as a project need. If safety has been included in project purpose and need, further analysis in the NEPA process can determine if the project will meet the stated safety need.

Guidance in Practice

Projects have begun to incorporate the guidance. One such example is PennDOT's *Final Purpose and Need for the State College Area Connector Planning and Environmental Linkages (PEL) Study* (PennDOT, 2021c). This study offers a good example of how safety analysis, incorporated into pre-NEPA documentation, can serve as

the foundation for incorporating safety in the purpose and need documentation.[1] The study purpose statement identified safety as a need, stating:

> *"The purpose of this study is to develop and evaluate a range of alternatives to improve mobility and meet interstate and regional through traffic and local needs by reducing congestion, addressing safety, and improving system continuity within the study area while accommodating other modes of traffic (bike, pedestrian, horse and buggies, farm equipment traffic, and public transit) where appropriate, and supporting regional land use visions and goals"* (PennDOT, 2021c; p. 39).

The study then reinforced this assertion by documenting potential safety issues based on safety performance analysis (see figure 2):

- *"PA 45 between Elks Club Road and the PA 144 intersection has narrow lane widths and shoulders, with the presence of horizontal curves and passing zones, numerous driveway access points, and hazards adjacent to the roadway (limited clear zones). The HSM analysis indicates a potential for safety improvements in this area as the expected (normalized) number of crashes is higher than the predicted (baseline) number of crashes.*
- *PA 144 between Centre Hall and Pleasant Gap exhibits roadway conditions similar to PA 45, but also has long stretches with steep grades and horizontal curves. The HSM analysis also indicates a potential for safety improvements in this area as the expected (normalized) number of crashes is higher than the predicted (baseline) number of crashes.*
- *Although recent improvements along US 322 have reduced crash frequency and crash severity throughout the corridor, the HSM analysis results indicate the potential for safety improvements at unsignalized intersections. Increasing traffic along US 322 has reduced the number of gaps available for side street and driveway traffic attempting to enter US 322. This causes drivers to make turning movements outside of their comfort zone which contributes to crashes at side street and driveway intersections. Additionally, the large percentage of through traffic exacerbates the issue as these drivers may be unfamiliar with the roadway characteristics. Similar conditions exist at the unsignalized intersections along PA 144"* (PennDOT, 2021c, p. 38).

[1] 23 U.S.C §168 provides more detailed explanation for how existing planning products may be referenced in the formal NEPA process.

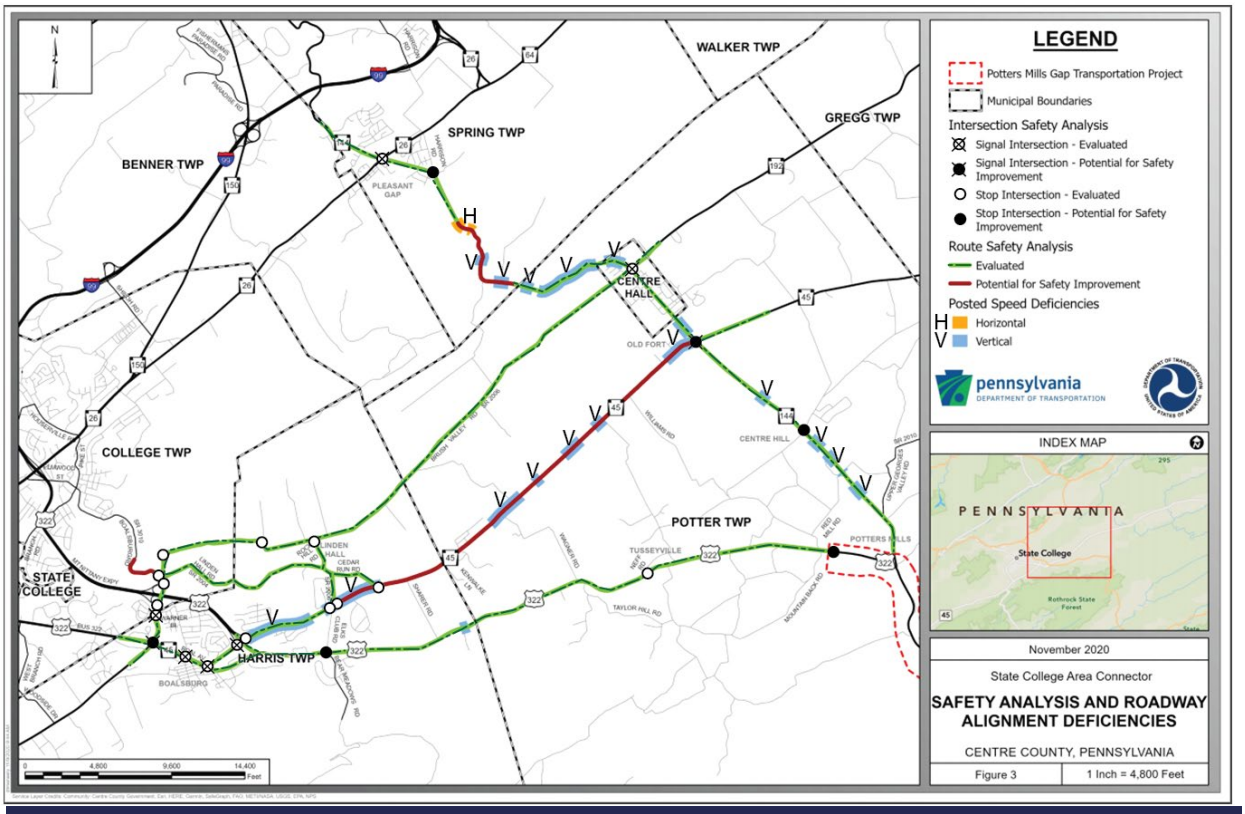

Figure 2. Graphic. Map of State College Area Connector Project.
Source: PennDOT, 2021c.

The Handbook, as illustrated by the State College Area Connector PEL study, helps PennDOT effectively incorporate safety in the NEPA process, particularly when other needs are documented in addition to safety.[2]

Florida DOT Safety Analysis Guidebook for Project Development & Environment (PD&E) Studies

FDOT developed the *Safety Analysis Guidebook for PD&E Studies* (Guidebook) (FDOT, 2019) to provide project managers and other practitioners with direction for integrating safety performance analysis into the PD&E process. As a NEPA assignment state, Florida's PD&E planning process is part of the State's procedure for complying with national NEPA standards for federally funded projects. FDOT project managers, environmental staff, and environmental practitioners (as well as others who conduct work on behalf of FDOT) comprise the audience for the State's PD&E guidance. The Guidebook establishes a uniform process and format for conducting safety analyses within the context of PD&E studies. This includes example applications and interpretation of results.

Connections to Safety

As part of the Guidebook's goal to institutionalize safety analyses within PD&E studies, the guidance includes recommendations for:

[2] The PEL study is currently ongoing and is not yet complete at the time of this case study's publication.

- Defining the scope of safety analysis within PD&E studies.
- Applying safety analysis tools and procedures consistently and accurately understanding crash contributing factors.
- Identifying potential countermeasures that address project purpose and need (FHWA, 2022a).
- Evaluating the potential safety performance effects of design alternatives.
- Improving the documentation and interpretation of safety analysis results.

The Guidebook notes that with respect to purpose and need development,

> *"If safety is the primary need for a project, the primary purpose and need should include results of a safety analysis to define the problem, summarize existing conditions, reference applicable safety plans, incorporate the results of public involvement related to safety (if any), and address the safety need of all road users on the project area*" (FDOT, 2019, p. 8).

The Guidebook also presents a list of safety-related themes that project managers should consider during purpose and need development. Like the PennDOT Handbook, these themes reinforce the need for safety performance analysis to guide further safety review. This can take the form of:

- Emphasis areas documented in the Strategic Highway Safety Plan (SHSP) or long-range transportation plan (LRTP). This should be accompanied by a crash data review to demonstrate a project's applicability.
- Crash history reviews, RSAs, or field observations.
- Crash rates compared to statewide or district averages, with additional statistical confidence intervals, for similar facility types.
- Use of network screening safety performance functions (SPFs) to determine if expected crashes exceed predicted crashes and a potential for safety improvement (PSI) exists.
- Incorporating safety considerations for all users, including the most vulnerable in a crash such as the elderly, children, disabled, motorcyclists, pedestrians, and bicyclists.

Based on these themes, the Guidebook states that the project team should determine if the project:

- *"Affects intersections or roadway segments identified by FDOT as priority safety improvement locations.*
- *Includes locations with safety concerns or potential for safety improvements in the project area as identified in previously completed planning studies, safety studies, or by the public.*
- *Affects a location that is known or anticipated to have potential for safety improvement—i.e., high crash location.*
- *Involves pedestrian, bicycle, transit, and commercial vehicles that require special considerations in the project area.*
- *Involves geometric elements that are crash-contributing factors and need to be addressed in the project.*
- *Involves special features of the proposed project and its surrounding environment that might have safety implications"* (FDOT, 2019; p. 8).

FDOT's guidance also notes that if the purpose and need includes safety without sufficient data or analysis, the project team should refine the purpose and need during the PD&E phase. This should involve an analysis of historic crash patterns and use of predictive methods to determine excess expected average crash frequency (FDOT, 2019; p. 8).

Guidance in Practice

Combee Road (State Road 659) is a two-lane undivided minor arterial in Polk County, Florida. This suburban corridor has a mix of residential, commercial, and light industrial uses, and the facility lacks multimodal infrastructure to accommodate the bicycle and pedestrian traffic observed at the location. FDOT initiated a PD&E study as part of the environmental review process for federally funded projects. The study's purpose and need identified safety as a primary need in conjunction with other safety-related needs based on the corridor's context:

- **Modal Interrelationships:** Enhancing mobility and access on the corridor for all road users based on context-sensitive design.
- **Safety:** Reducing conflicts between drivers and other road users.
- **Transportation Demand:** Accommodating the mix of modes as well as increasing capacity on the corridor.
- **Social and Economic Demand:** Promoting aesthetics and economic activity, as well as providing access to schools, churches, and restaurants in the area.

FDOT reviewed historic crashes and held public meetings to discuss potential alternatives as part of the PD&E study's preliminary engineering report (PER; FDOT, 2022a). The crash review noted that the corridor experienced a crash rate as much as three times higher than the statewide average for a similar facility (2014-2018). Furthermore, the analysis noted that rear-end and angle crashes also tended to cluster around signalized intersections, and congestion led to rear-end crashes on the mainline between intersections. Although the corridor only experienced three bicycle and pedestrian crashes during the study period, public comments noted concerns for the safety of these road users.

Safety performance analysis is also provided in the *Alternatives Analysis* section of the PER. The FDOT team conducted an Intersection Control Evaluation (ICE) for five signalized intersections on the corridor. The ICE screening is a performance-based evaluation process that assesses intersection design and traffic control alternatives based on operational, environmental, economic impact, cost, and safety metrics. With respect to safety, these metrics include anticipated crashes based on SPFs and crash modification factors (CMFs). The ICE screening consisted of two stages: 1) assessing the feasibility of signalized and roundabout alternatives, and 2) determining the benefit/cost ratio associated with roundabout alternatives to determine where they were appropriate. The PER recommended roundabouts at two of the five locations based on the ICE results, Maine Avenue and Skyview Drive.

The PER results directly informed the project purpose and need, as well as the final preferred alternative. The Categorical Exclusion's (CE's) purpose and need states:

> *"SR 659 (Combee Road) has a safety ratio that ranges between 1.3 and 2.9, indicating that there are between one to almost three times as many crashes on this corridor than the State average for a similar facility type. Between 2014 and 2018, the majority of crashes (52%) on SR 659 (Combee Road) were rear-end crashes. The high rate of this crash type is likely attributed to congestion during peak hours at intersections and where left turning traffic frequently blocks travel lanes. Additionally, the project facility experienced two collisions involving pedestrians and one involving a bicycle. If no improvements occur to the existing roadway, there will be a greater opportunity for vehicle-to-vehicle and vehicle-to pedestrian/bicycle conflicts as traffic increases along the project facility."* (FDOT, 2022b; p. 5).

The preferred alternative incorporated the recommended roundabouts, as well as facilities to accommodate both bicyclists and pedestrians:

> *"The preferred alternative will reconstruct the roadway with a 13-foot-wide TWLTL, one lane in each direction, type F curb and gutter, and 8-foot-wide sidewalks. Although the preferred alternative does not include bicycle lanes, cyclists will be accommodated on the road or can utilize the proposed wide sidewalks. This alternative has a 4-foot grass buffer from the road to the sidewalk, reduces the hazard to cyclists from turning trucks, and allows for greater avoidance of above-ground utilities.*
>
> *The preferred alternative includes roundabout intersections at Maine Avenue and Skyview Drive. The traffic signal control at Commerce Point Drive, South Crystal Lake Drive, and North Crystal Lake Drive will remain but with enhanced multimodal accommodations such as crosswalks and pedestrian signals at all quadrants."* (FDOT, 2022b; p. 4).

Ohio DOT Guidance for Developing Purpose and Need

ODOT instituted the Project Development Process (PDP) as a project management and decision-making workflow from an initial concept through project completion. The PDP Manual provides guidelines to encourage multidisciplinary communication, improve the quality and consistency of project documentation, streamline project activities, and quickly identify potential issues. The Manual details this process and provides guidance for each phase of project development (figure 3).

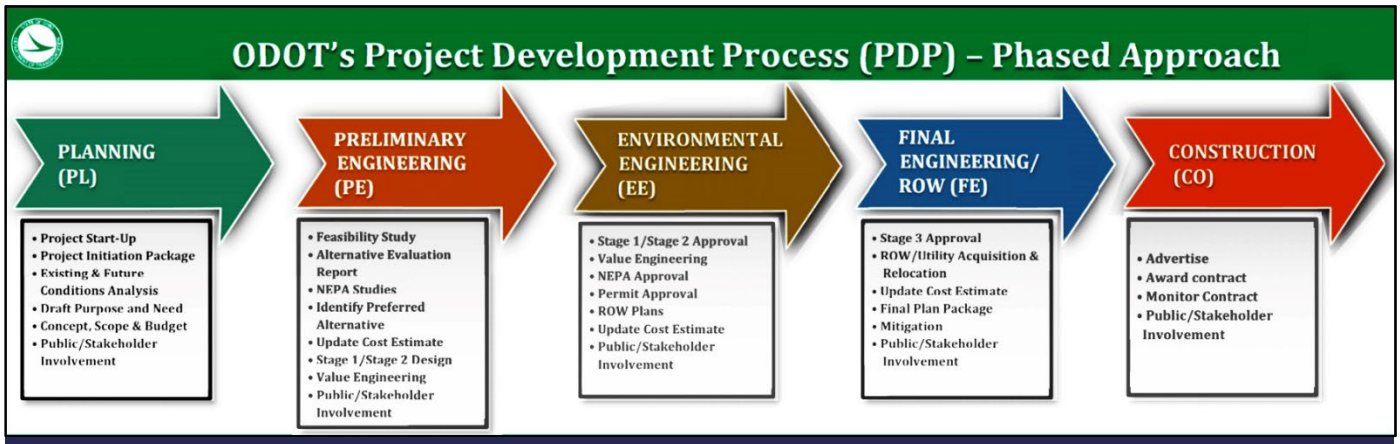

Figure 3. Graphic. ODOT's PDP.
Source: ODOT, 2018.

The five phases of project development provide structure for the Manual, and the Manual guides practitioners along the specific tasks, analyses, and deliverables associated with each phase. The guidance adopts the Performance Based Project Development (PBPD) concept that places emphasis on safety performance analysis and operational performance rather than strict adherence to standards (i.e., nominal safety).

Figure 3 illustrates that purpose and need begins in the project planning phase. This establishes project needs early and dictates appropriate analysis and design decisions later in the process. ODOT's *Guidance for Developing Purpose and Need* (Guide) supports transportation professionals, environmental specialists and project managers that prepare and review purpose and need statements for ODOT (ODOT, 2019). At a conceptual level, the guidance helps these practitioners:

- *"Recognize the importance of having a purpose and need.*

- » *Identify at what point in ODOT's PDP a purpose and need is prepared.*
- » *Identify transportation-based needs.*
- » *Identify Primary and Secondary Needs and how that is key for integrating PBPD into the purpose and need.*
- » *Provide a baseline to effectively develop, evaluate, and eliminate or advance alternatives"* (ODOT, 2019; p. 2).

These general guidelines also include recommendations for effectively incorporating safety in project purpose and need.

Connections to Safety

ODOT's purpose and need guidance notes that safety is often related to other project needs (e.g., mobility, congestion, or access management). The Guide recommends a two-step process to effectively establish safety as its own need (i.e., rather than a general statement that may actually closely relate to other needs). The steps include:

1. A review of Safety Integrated Project (SIP) maps that identify high-priority locations based on crash history. SIP locations are stratified into two categories, 1) locations where more, higher-cost improvements may be warranted (e.g., funded by the HSIP) and 2) locations where low-cost proven safety countermeasures may be more appropriate.
2. If the location is not flagged on the SIP maps, project managers and practitioners should review the most recent three years of crash data from ODOT's GIS Crash Analysis Tool (GCAT). This review should consider discernable crash patterns (e.g., consistent and similar crash types), particularly if fatal or suspected serious injury crashes have occurred.

Once a project has established safety as a need based on historic review, ODOT practice requires proposed alternatives to be reviewed as part of a Feasibility Study (FS) and Alternatives Evaluation Report (AER). This analysis includes HSM methods such as project-level SPFs that predict a future number of crashes based of traffic and design criteria. Analysts can use this safety performance analysis to determine if proposed alternatives are expected to address safety as a need.

Guidance in Practice

The Interstate 670 (I-670) and I-270 interchange modification outside of the City of Columbus is an example of ODOT's purpose and need guidance in practice with respect to safety. The project's purpose primarily focuses on congestion relief and added capacity, but safety is noted as a project need within this larger purpose. This is established in the CE's purpose and need statement, and it references the historic crash review conducted early in the planning process:

> *"Crash data for the I-670/I-270/US 62 interchange reflect congestion concerns, specifically, rear-end and sideswipe passing crashes can be related to congestion problems and/or large speed differentials. The statewide average for rear-end collisions on freeways is approximately 30% of all crashes, and the statewide average for sideswipe passing collisions on freeways is approximately 19% of all crashes. On eastbound I-670 in the interchange area, 70% of the 70 crashes in 2014-2016 were rear end collisions. On northbound I-270 in the interchange area, 64% of the 198 crashes in 2014-2016 were rear end collisions and the 25% were sideswipe passing collisions"* (ODOT, 2017a; p. 41).

Since the project identified safety as an explicit need, a companion FS documents the alternatives analysis based on HSM methods prior to the NEPA review (i.e., project initiation in figure 3). The 2017 *I-670 and I-270 Interchange* FS documents the four alternatives considered (i.e., a No-Build and three proposed Build alternatives), as well as the safety analysis conducted by project staff (ODOT, 2017b). The analysis used

freeway analysis methods found in Chapters 18 and 19 in the HSM. The project team segmented the interchange into homogenous segments based on consistent design elements and used ODOT's Economic Crash Analysis Tool (ECAT) to develop predictions.

The analysis determined that all three proposed alternatives would have fewer crashes per mile per year compared to the No-Build alternative. A further analysis noted that the human costs, based on crash severity and type and associated costs, are lower per mile per year for all three proposed Build alternatives compared to the No-Build alternative. A subsequent Interchange Modification Study (IMS) identified the preferred alternative for the project and compared it to the No-Build option (ODOT, 2017c). With respect to safety, the IMS noted the findings in the FS that demonstrated that the preferred alternative would have fewer crashes (including fatal and suspected serious injury) per mile per year than the No-Build option. The combination of the FS and IMS provided the safety performance justification for NEPA documentation.

Conclusion

Purpose and need is the benchmark for a project, and project needs should reflect quantitative parameters that the project intends to address. The NEPA process is intended to demonstrate that a project alternative addresses project purpose and need through an evaluation of these parameters and minimizes potential impacts. Like other transportation needs (e.g., congestion and delay), safety should only be incorporated in purpose and need when safety performance issues can be quantified, and alternatives can demonstrate their effectiveness in addressing this need.

The example guidance in this case study highlights how State DOTs and their partners can effectively and practically define safety as a need in the NEPA process. Common themes and applications from ODOT's, FDOT's, and PennDOT's guidance include:

- Safety as a project need requires data and documentation. This can come in several forms, such as:
  - Local observational studies, such as RSAs or other site visits.
  - Input from stakeholder engagement and public involvement.
  - A consistent, data-driven analysis of historic crashes and common patterns.
  - HSM-based analysis and network screening, particularly using predicted and expected crashes compared to observed crash history (i.e., as opposed to simple crash frequency or crash rates).
- Nominal safety (i.e., addressing perceived design deficiencies alone) is not a valid justification for safety as a need alone; safety performance analysis should determine if a need exists and can be addressed by the proposed alternatives.

The methods described in the HSM are the principal means for conducting safety performance analysis. States have progressively incorporated the HSM and its prescribed methods since the HSM's publication in 2010, and additional guidance on incorporating the HSM in project development is available (FHWA, 2016). There are numerous additional examples of how States have used the HSM for project development in FHWA's Roadway Safety Data Program case study repository (FHWA, 2022b). Several case studies demonstrate opportunities for agencies to define and quantify safety as part of project purpose and need.

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