Planning: Crash Analysis SOP

**Objective/Purpose/ Why:** To analyze crash data and generate a report of findings at an appropriate level of detail to support the scale/scope of the project in which the crash analysis is to be incorporated.

Outputs from a well performed crash analysis inform decision making for capital investments and in most cases, support a state, or regional client’s ability to support a federally compliant multimodal planning process.

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**Process Outline:**

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Step 1: Review Contract/RFP/PMP and Document Task Scope.

Document the expected deliverables and/or scope requirements as relate to safety analysis. It is recommended to use a workbook or similar organizational method to document and detail scope requirements, data requirements, public involvement needs, expected outcomes, work products, deliverables, etc.

For most Metropolitan Transportation Plans, crash analysis covers at the very least the Federal Highway Administration (FHWA) Performance Measure (PM) 1 requirements (detailed in step 5). For other studies (e.g., corridor studies) alternate performance measures and levels of detail may be required. This SOP is intended as an overview of a general approach to safety/crash analysis for MTPs and is not intended to be an exhaustive primer on safety analysis.

If the scope is under development, then the person developing the crash analysis scope should review each step in this SOP and include elements in the scope to provide guidance to the client on the elements outlined in this SOP. For example, the data and tools expected to be available, the years the analysis should cover (or how to select them during the study), the level of reporting, the metrics to be produced, etc.

**Step 1 Expected Work Product**

At the end of this step, you should have an outline of the task work product with a clearly stated scope description and a list of deliverables. This outline will provide the bones to develop the resulting safety needs analysis memo.

Step 2: Identify and Document Data and Tools Needed

Data and tools needed will vary depending on level of scale and scope requirements.

1. Based on scope requirements documented in step 1, develop a list of data and tools needed to accomplish the task as outlined. *This should include a request for a data dictionary and/or meta data*.
2. Provide data request to project PM/DPM and or Task Leader to include in data request to MPO, including clearly defined span of data, i.e., range of time covered by data. For federal compliant performance measures, this must be at least 5 years of the most recent validated data. This is also noted under the following section on data inputs.
3. Once the data is provided, review provided data to ensure necessary fields have been provided and data is in a useable/accessible format. Data should be documented in project data log as referenced in step 3.

**Note:** MTPs in different states may require different sources for crash data. Within the same state, depending on scope between MTPs the attributes used in analysis may vary as well. FHWA, LADOTD, TxDOT, etc. crash data sets do not necessarily follow the same format or contain the same attributes. Examples of fields typical fields in LADOTD and TxDOT data sets are provided in the Resources section of this SOP.

**Typical Data/Information Inputs**

* 5 yrs. of Crash Data – Typically provided by State DOT. Request may need to come from MPO to access data. 5 years is typical, but the range may be more or less, depending on the type of study and what you in your professional opinion provides the best answers to the questions the study is trying to answer. (See notes on rolling 5-year averages in Step 4 below).
  + Attributes included in crash data should include at the very least the following information:
    - Number of fatalities.
    - Number of severe injuries.
    - Number of non-motorized fatalities.
    - Number of non-motorized serious injuries.
    - Latitude and Longitude
    - Facility/street name
    - Intersecting street name (if applicable).
  + Additional attributes to request if available
    - Posted speed.
    - Adjusted AADT.
    - Percent AADT truck/commercial traffic.
    - Contributing factor.
    - Collision type.
    - First harmful event.
    - Occupant protection information (seat belts, car seats, helmets, etc.).
    - Lighting, weather, and time of day conditions.
    - Traffic control type.
    - School zone indicator.
* Data dictionary and/or meta data with all primary data sets.
* 5 yrs. of VMT – May be provided by State DOT or extrapolated from regional Travel Demand Model.
* Statewide Strategic Highway Safety Plan (SHSP). Goals, objectives, emphasis areas, and targets should be noted from statewide and regional safety plans. This may overlap or be drawn from the plan review performed under a separate task for the MTP.
* Regional SHSP(s). – see above note on items to draw from plans.
* Stakeholder Interviews, Visioning Results, and Public Involvement Feedback.

**Typical Tools Used in Analysis**

* Geographic Information System software
  + May include Esri and macro travel demand modeling software.
* Excel/Access.
* Diagraming/graphical representation software.
  + May be native graphs from Microsoft Excel, Access, Adobe Creative Cloud, or other software used to graphically represent data.

**Step 2 Expected Work Product**

At the end of this step, you should have documentation of the data and tools needed to complete the analysis. Documentation should also reference general methodology to be used and reference to FHWA PM1 requirements. This work product is an integral component of the task documentation and will be provided as a resource to the client. As such it needs to follow project QA/QC procedures.

Step 3: Prepare Data for Analysis

Crash data is not always GIS ready and may need to be processed or cleaned prior to input into a GIS program. Additionally, the crash data may have a large number of attributes and may need to be pulled into separate workbooks for the various components of the safety analysis.

*Refer to Plan Mapping SOP for data input requirements and guidance on data prep for mapping.*

*<INSERT LINK TO PLAN MAPPING SOP ONCE COMPLETE>*

**Step 3 Expected Work Product**

At the end of this step, you should have sets of working data that are ready for plotting and analysis/summary. Working data sets should be saved separately from “raw” data.

Step 4: Analyze Data

1. Prepare summary statistics, tables and a brief writeup within the outline established in step 1. Reviewing summary statistics for at least contributing factors, collision types, and first harmful event before mapping will better inform which trends may need to be mapped. This summary is typically performed for regional and historic trends. The following represents components of a typical crash analysis and may be used as a toolbox to fulfil the scope requirements you documented in step 1.
2. For most of the following analysis components, the outputs would include totals, annual trends, 5-yr totals, and 5-yr averages. If the scope has specified a comparison of 5 year rolling averages, then the data request will need to have included 9 years’ worth of data in order to compare averages for each progression of 5-year spans. Outputs of the safety analysis will typically be represented in summary tables and graphs. Hotspots and top crash locations may be represented in maps as well. 1 through 3 below represent typical federally required components.
   1. Total person level outcomes by severity, type of person, and occupant protection level. ***Person level outcomes will include details needed to complete FHWA PM1 metrics being 5-yr averages of***:
      1. Number of Fatalities
      2. Rate of Fatalities per 100 million Vehicle Miles Traveled (VMT)
      3. Number of serious injuries
      4. Rate of serious injuries per 100 million VMT
      5. Number of non-motorized fatalities
      6. Number of non-motorized serious injuries
   2. Compare previous reported 5-yr averages and targets with current 5-yr averages and document difference (usually represented in percent difference).
   3. Compare 5-yr. averages to statewide metrics. Some clients will want to compare to regional data or other counties, etc. But statewide is preferrable because it more reliably and consistently reported.
   4. Total crashes, top collision types, crash contributing factors, first harmful events.
   5. Crashes involving non-single occupant vehicles such as transit and commercial vehicles, freight/cargo carriers, etc.
3. Geocode key crash data utilizing latitude and longitude attributes in each file.
   1. Map crash data and generate crash hotspots for the following. If available, it is preferable to use Vehicle Miles Traveled (VMT) to normalize crash counts by volume to better account for low volume roads where there may be more crashes proportional to the volume of traffic. If VMT is not available, using adjusted average daily traffic counts may be acceptable to show crash rates at the segment level. A typical measure for DOT or MPO studies is crashes per 100 million VMT.
      1. All crashes.
      2. Fatalities and severe injuries (all).
      3. Non-motorized fatalities and severe injuries.
   2. Compare normalized hotspot maps to working data and if street names, intersecting street names, or control sections are available in the data set then generate a list and map. Report, if possible, by facility type, e.g., Interstate, non-interstate NHS, primary arterial, divided, undivided roadways, etc. and include:
      1. Top intersections by crash rate (all crashes) – usually top 10, may vary by size of region.
      2. Top roadway segments by crash rate (all crashes) – usually top 10, may vary by size of region.
   3. If no street names, intersecting street names, or control sections are available, an alternative method using TDM segments is represented in the Appendix of this SOP.
4. Save a combined shapefile for future mapping.
5. Review stakeholder interviews and public engagement feedback from surveys, polls, etc., for other safety concerns.
   1. Additional considerations might include Freight network and industrial flows, safety parking needs and requirements as well as considerations for crash modification factors or any feedback on proven safety countermeasures.
6. Initiate Data Analysis QA/QC process as defined in relevant Planning Practice QA/QC SOP.
7. Address comments if applicable.

**Step 4 Expected Work Product**

At the end of this step, you should have sets of summarized data that encompass scope requirements, including draft tables, graphs, maps, and preliminary notations of findings.

Location of final QC’d workbooks should be noted in data log in correspondence to original raw data sets.

Step 5: Compile Analysis and Draft Deliverables

1. Finalize tables, graphs, and maps.
   1. If data and project maps have been QC’d and approved by QA/QC manager, then package map projects/data/metadata for delivery to client.
2. Fill in write-up with findings/statistics of existing transportation safety conditions.
   1. For each component of the safety analysis performed, provide a narrative review of the findings, e.g., “top contributing factors were…”
   2. For maps, include discussion of area, bounds/impacts of what is shown, e.g., “figure x shows the top three crash corridors which are [insert names of roads/extents] and are adjacent to…”
   3. Review public/stakeholder input as well as safety related planning documents (SHSP) and include details as mentioned in step 2 in narrative review of findings.
3. Finalize draft memo and initiate QA/QC process as detailed in SOP.
   1. Note: for QA/QC in documentation and analysis steps, the following questions should be considered:
      1. Is the reporting consistent?
      2. Is the writing/analysis clear about whether we are reporting actual numbers or averages?
      3. Are we reporting intuitively reasonable outcomes? For example, the difference between saying there were 1.5 fatalities in each of the 5 years versus saying there were between 1 and 2 fatalities.

**Step 5 Expected Work Product**

At the end of this step, you should have a draft technical memo detailing purpose/scope, data sources, tools, methodology, analysis, and outcomes. This work product is the culmination of steps 1 – 5 and will become the final deliverable once the full QA/QC process is completed.

Sample safety analysis tech memos can be found at the file paths indicated in the following Resources section of this SOP.

Resources

These resources include additional approaches referenced above to accommodate a number of varying conditions in data sources and availability.

Data Set Examples

These examples are up to date as of the current revision of this SOP and may require update if/when LADOTD and TxDOT revise the data they provide. Additionally, the file paths to these examples will need to be updated once the projects are closed out and archived.

LADOTD

Z:\Planning\PLDV-2020.0031 NLCOG MTP 2020\Data\Safety Data

TxDOT

Z:\Planning\PLDV-2021.0012 Temple Mobility Master Plan\Mapping\Task\_5\_SafetyAnalysis\Data\Excel

TDM Method for Identifying Top Segments/Intersections

1. Set a query in the network shapefile so that everything but centroids equal true.
2. Create a buffer around the TDM with a radius of your choice depending on local context (we have done 150ft in the past, but something like 50ft may be better for intersections).
   1. Do not dissolve the TDM segments into one feature.
3. Once the buffer is created, create a spatial join with the buffer and the crash data point layer.
   1. To identify intersections, query the crash data so that the Intersection Related attribute is only equal to “Intersection” (If an intersection related flag is available in the data set).
   2. To identify segments, perform the inverse query to equal only “Non-intersection.”
4. For each operation, once the two layers are joined, a JOIN\_COUNT column will be created within the buffer attribute table which should have summarized the number of crashes that occurred within the segment, or intersection of the TDM Network respectively.
5. Review the segments and intersections that recorded the highest number of crashes by volume (ideally VMT, but Adjusted AADT may be used as well).
   1. Many of these segments may overlap each other, but this method will save you time by identifying segments with high concentrations, allowing you to pinpoint the top intersections/segments vs eyeballing a heat map more easily. This will also give you crash counts/rate.
6. If needed, once you have manually identified/selected the crash points that belong to each intersection/segment, you can export the selected features at each intersection/segment to make further analysis easier layer on (i.e., identifying the number of bike/ped crashes at top intersections)

Example Crash Analysis Memos

The file paths to these examples will need to be updated once the projects are closed out and archived.

RGVMPO MTP Safety Analysis

Z:\Planning\PLDV-2019.0135 RGVMPO 2020-2045 MTP Update\Deliverables\Task 1 Deliverables\Needs Analysis\Safety Analysis

NLCOG 2045 MTP Safety Analysis

Z:\Planning\PLDV-2020.0031 NLCOG MTP 2020\Tasks\Task 12 Metropolitan Transportation Plan Preparation\\_Technical Memos\Draft Memos\20210401\_NLCOG Safety Analysis Memo.docx

Definitions: Key Terminology

**AADT** – **Annual average daily traffic**. Traditionally, it is the total volume of vehicle traffic of a highway or road for a year divided by 365 days.

**CMFs** – **Crash modification factors**. A crash modification factor (CMF) is a factor used to calculate the *expected* number of crashes after implementing a given countermeasure at a specific site. These factors are elements used in project development and are accepted as a computational input in calculating expected reductions in crashes.

**Contributing factors.** Factors, actions, or phenomena playing a contributing role in the development of a safety event. This could include things such as distracted driving, excessive speed, improper passing, etc.

**DOT** – Department of transportation

**FHWA** – Federal Highway Administration

**LADOTD** – Louisiana Department of Transportation and Development. The State DOT for Louisiana.

**Proven safety countermeasures.** In 2008, FHWA began promoting certain infrastructure-oriented safety treatments and strategies, chosen based on proven effectiveness and benefits, to encourage widespread implementation by State, tribal, and local transportation agencies to reduce serious injuries and fatalities on American highways. This became known as the Proven Safety Countermeasures initiative. The list was updated in 2012 and again in 2017. [[1]](#footnote-1)

**SHSP – Strategic Highway Safety Plan**. A Strategic Highway Safety Plan (SHSP) is a major component and requirement of the Highway Safety Improvement Program (HSIP) (23 U.S.C. § 148). State DOTs must have a statewide-coordinated safety plan that provides a comprehensive framework for reducing highway fatalities and serious injuries on all public roads. At times regional planning agencies or MPOs may sponsor regional or even County/Parish level SHSPs in support of the Statewide SHSP.

**TxDOT** – Texas Department of Transportation. The State DOT for Texas

1. <https://safety.fhwa.dot.gov/provencountermeasures/> [↑](#footnote-ref-1)