

**Introduction**

Travel time reliability is a function of the variability between the expected travel time (usually taken as free-flow travel time) and the actual travel time over a very large number of trips. Travel time reliability is mainly affected by high demand/capacity ratios, weather events, incident events, and work zone events. Two recently developed TTR analysis methods are effectively the current standard to analyze travel time reliability : one based on the results of a Strategic Highway Research Program (SHRP) research project (hereafter referred to as "SHRP2-L08"), which is documented in the fifth edition of the Highway Capacity Manual (HCM) and the other a modified version of the SHRP2-L08 methodology that is included in the sixth edition of the Highway Capacity Manual, hereafter referred to as the "HCM" method.

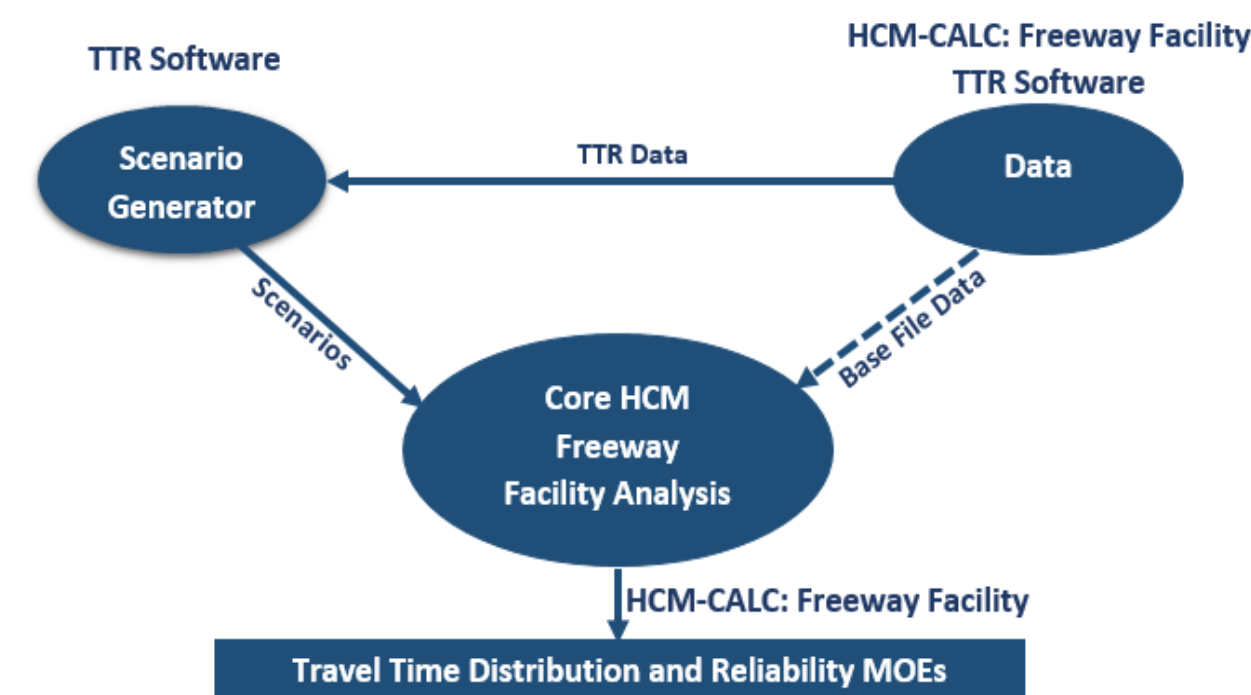
**Objective**

One thing common to both TTR analysis methods is that they are data intensive, and consequently computationally intensive. While the SHRP2-L08 project report and HCM document the respective analysis methodologies, it is not feasible to conduct the travel time analysis methods without software, given the large scale and highly iterative calculations.

The objective of this project was to develop a software tool for executing the SHRP2-L08 and HCM TTR analysis methodologies (specific to freeway facilities). Furthermore, this software tool meet the user friendliness and functional requirement standards of transportation practitioners such that the application of these TTR analysis methodologies will be as intuitive and efficient as possible.

**Software Development**

The TTR software is built with the C# programming language and the .NET Framework. The TTR software program developed in this project is designed to utilize the HCM-CALC Freeway Facility software module for setting up the base facility network file and to perform the HCM freeway facilities analysis methodology calculations on each generated scenario from the software tool.



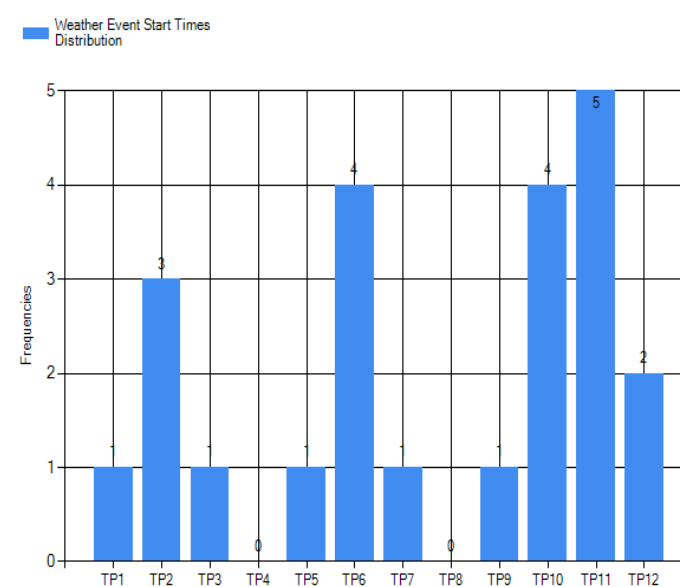
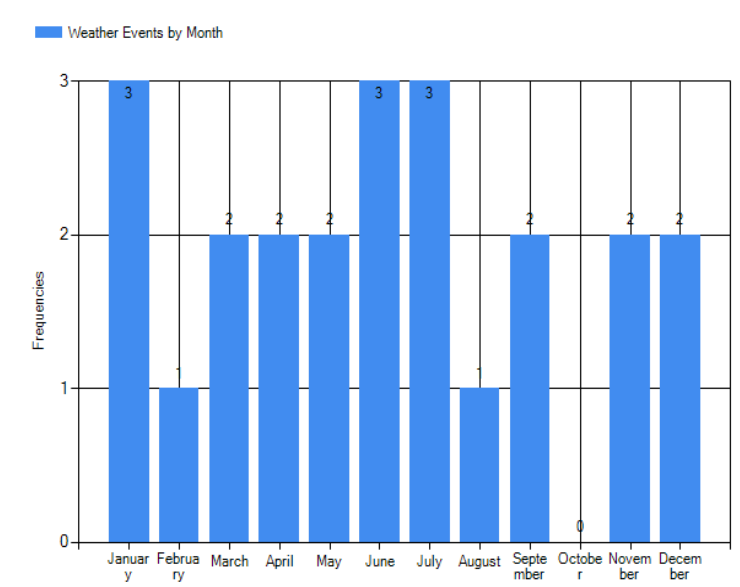
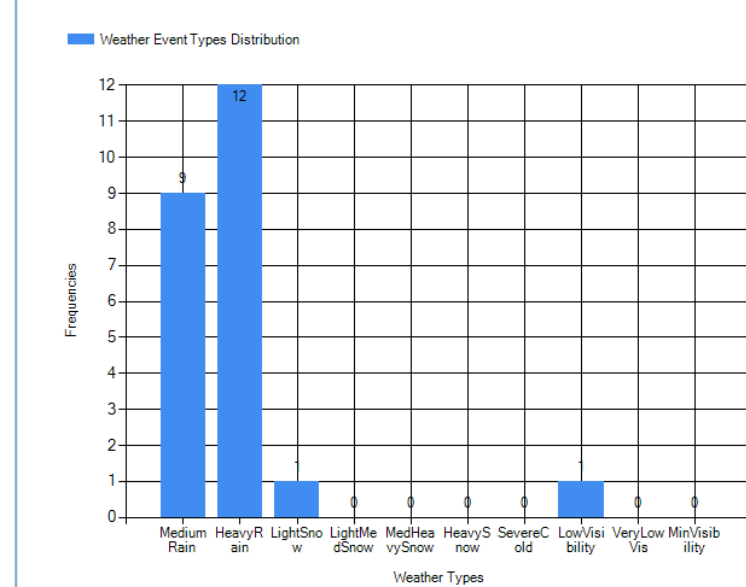
**Procedures of Conducting TTR Analysis through the Software**

**Basic Procedures**

- A base file that includes the basic facility information (facility geometry, demand entry flow rates, etc.) is generated through Freeway Facility software module. TTR variable data (demand, weather and incident variability information) are specified through the TTR user interface (UI).
- The TTR software tool generates scenarios based on both the base file and the user-specified settings of demand, weather and incident inputs and pass the scenarios into the Freeway Facility software module for the core HCM freeway facilities analysis procedure calculation.
- The TTR software tool aggregates the scenario results obtained from the Freeway Facility software module into travel time distribution and calculates the reliability MOEs.

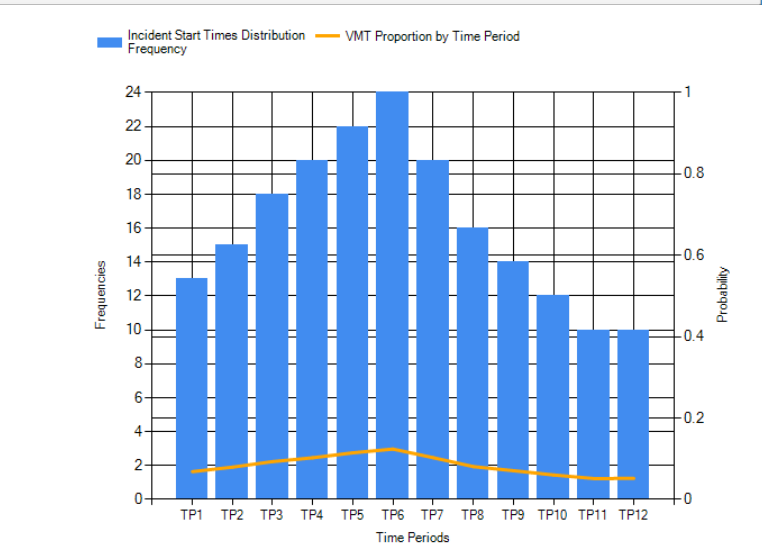
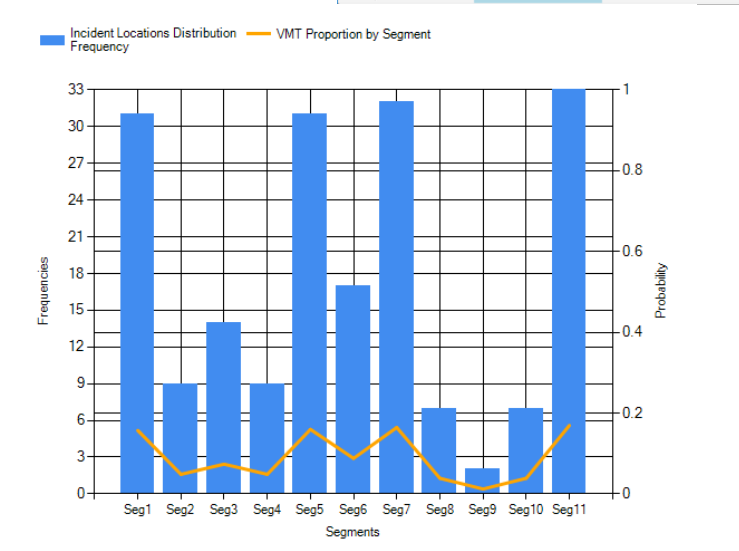
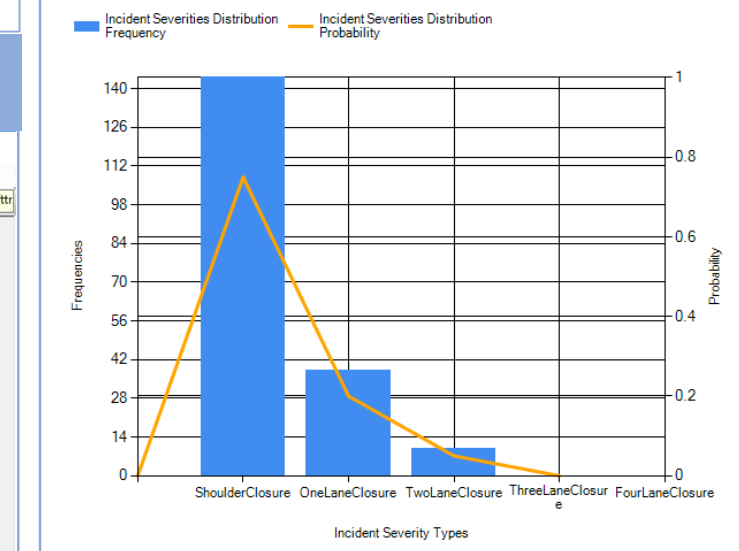
**Demand**

**Weather**



**Incident**

For the incident events, users can specify the incident rates, incident types distribution, incident duration parameters, etc. Then the software can generate random incident events based on these incident inputs.

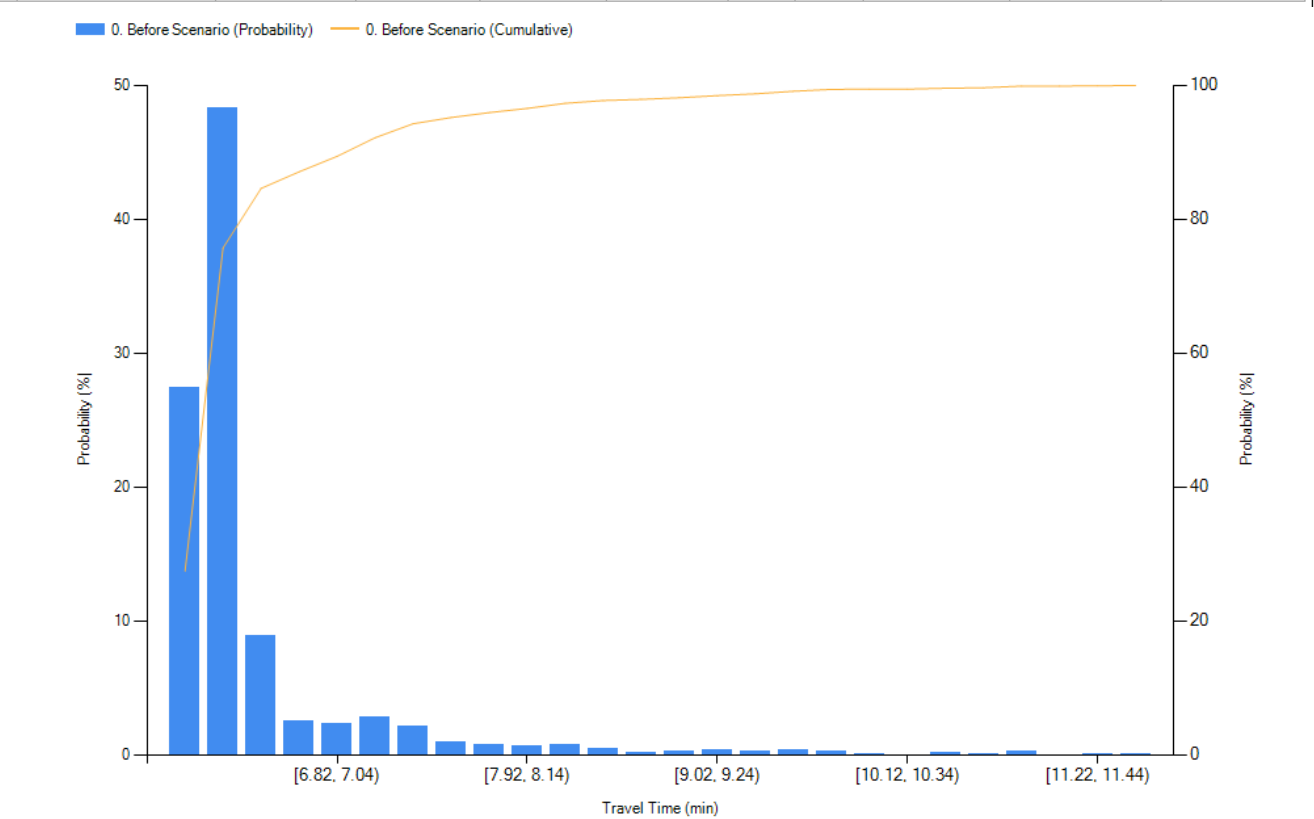


**Scenarios**

The software will generate the list of scenarios that contain the combinations of demand patterns, weather events, and incident events. For the HCM method, we will normally have 240 demand patterns, then the generated weather and incident events will be randomly assigned to those demand patterns, thus there will be 240 scenarios in total.

**TTR Results**

Plan ID	Description	Travel Time (min)	Travel Time Index	VMT (Demand)	VMT (Incident)	VMT	VHD	Speed Avg. (mi/h)	Density (veh/mi/h)	Density (mi/h/ks)
0	Before Scenario (Rel)	6.13	1.02	3351.00	57.12	1.27	30.95	12.35	12.66	
0	Before Scenario (Rel)	11.63	1.94	12779.25	9889.85	267.67	126.52	58.74	56.71	58.12
0	Before Scenario (Rel)	6.44	1.07	4482.67	6482.67	119.08	9.93	56.37	25.44	26.08
0	Before Scenario (Rel)	6.19	1.03	4225.25	6225.25	107.25	3.53	58.11	23.18	23.77
0	Before Scenario (Rel)	6.47	1.08	8316.00	8426.00	152.21	10.99	58.54	32.84	33.66
0	Before Scenario (Rel)	7.60	1.27	9581.25	9332.38	159.12	41.53	58.69	42.29	43.34
0	Before Scenario (Std. Dev)	0.65	0.11	1876.33	1823.69	42.54	17.06	4.28	9.11	9.34
0	Before Scenario (Mean Index)	1.47								
0	Before Scenario (Std. Dev)	2.42								



The generated scenarios are passed in the Freeway Facility module to perform the HCM freeway facilities analysis methodology. Then, the software aggregates the results of all scenarios and calculate reliability MOEs.

For more information please refer to the following website, which contains the user guide and Wei Sun's Master's thesis on the development of the software: [http://swashware.com/TTR\\_ATDM](http://swashware.com/TTR_ATDM)