

Travel Time and Delay

Travel time analysis calculates the amount of time needed to travel on a given route from one stage to another. Details on locations, dates, and causes of delay can be gathered while performing such studies. When this is completed, the analysis is regarded as a study of travel time and delay. The data obtained provide a clear indication of the quality of service on the study section. In order to enhance the overall flow of traffic on the road, the data also helps traffic engineers locate problem areas that may need special attention. In any one of the following traffic engineering activities, the knowledge collected in these studies can be used as:

- Determination of a route's productivity with regard to its ability to carry traffic.
- Identification of high delay locations and the cause of those delays.
- Performance of before and after studies to assess the efficacy of changes in traffic activity.
- Determination of relative route efficiency through the creation of sufficiency ratings or indices of congestion.
- Determination of travel times for use in trip assignment models on particular connections.
- Performance of economic studies in determining alternatives to traffic operations that reduce travel time.
- Measurement of free flow speed

Methods

To conduct the travel time and delay studies, there are usually two methods or we can say it depends upon the availability of test vehicle or the available personnel. Two general ways of conducting the test are:

- By using a test vehicle
 - Average speed technique
 - Moving vehicle technique
 - Floating car technique
- By not requiring a test vehicle
 - License plate observations
 - Interviews

Arrangement of the survey

In this analysis, the survey location was at Phoenix, AZ 85004, USA. The part of the road taken, E Lincoln St, had 8 intersections and the study was conducted by two observers.



Figure 1 Site Location

The observers recorded the time taken for the test vehicle to reach the initial and final milestone point in each direction. A total of 10 test runs were taken, 5 in each direction. A sample of the field study for a test run is shown below:

Direction: West to East						
Site: E Lincoln St.		Run No. 1	Start Location: Milepost 1			
Recorder: Tashdid Haque		Date: Aug 10	Start Time: 3:00 PM			
Milestone	Cum. Dist. Along Route (mi)	Cum. Trav. Time (min:sec)	Per Section			Special Notes
			Stopped Delay (s)	No. of Stops	Section Travel Time (min:sec)	
MP 2	0.075	0:32	0	0	0:32	
MP 3	0.15	1:08	0	0	0:36	
MP 4	0.23	1:54	0	0	0:46	
MP 5	0.3	3:45	35	1	1:51	Stop due to signal
MP 6	0.37	6:01	26	4	2:16	Stops due to double parked cars
MP 7	0.44	7:20	20	2	1:19	Stops due to signal
MP 8	0.52	8:40	0	0	1:20	
Section Totals	2.09		81	7	8:40	

Figure 2 Travel Time field sheet

Data Analysis

The calculation of true mean running time, 95% C.I travel time and histogram of actual travel time for all the runs are given below:

Run	Travel Time, s	Delay Time, s	Running Time, s	95% Confidence Interval	
1	520	81	439		
2	535	91	444		
3	547	67	480		
4	578	105	473		
5	595	104	491		
6	588	79	509		
7	599	78	521		
8	595	82	513		
9	572	81	491		
10	595	89	506	Upper Limit Travel Time	541.77
Total	5724	857	4867	Average Travel Time	486.70
Mean	572.4	85.7	486.7	Lower Limit Travel Time	431.63
SD	28.49	11.82	28.10	Lower Limit Speed, S1 (mi/hr)	13.89
				Average Speed, Sav (mi/hr)	15.46
				Upper Limit Speed, S2 (mi/hr)	17.43
				Total section, mi	2.09

Distribution of Signal Time		
No. of Signal Stop	Probability of occurrence	Duration of Stops, s
0	0.46	0
1	0.24	25
2	0.20	50
3	0.09	75
4	0.014	100
Average Delay Time, dav	23.93	
Average Travel Time, sec	510.63	
SD of histogram	9.875	

95% Confidence Interval	
Upper Limit Travel Time	529.98
Average Travel Time	510.63
Lower Limit Travel Time	491.27
Lower Limit Speed, S1 (mi/hr)	14.20
Average Speed, Sav (mi/hr)	14.73
Upper Limit Speed, S2 (mi/hr)	15.32
Total section, mi	2.09

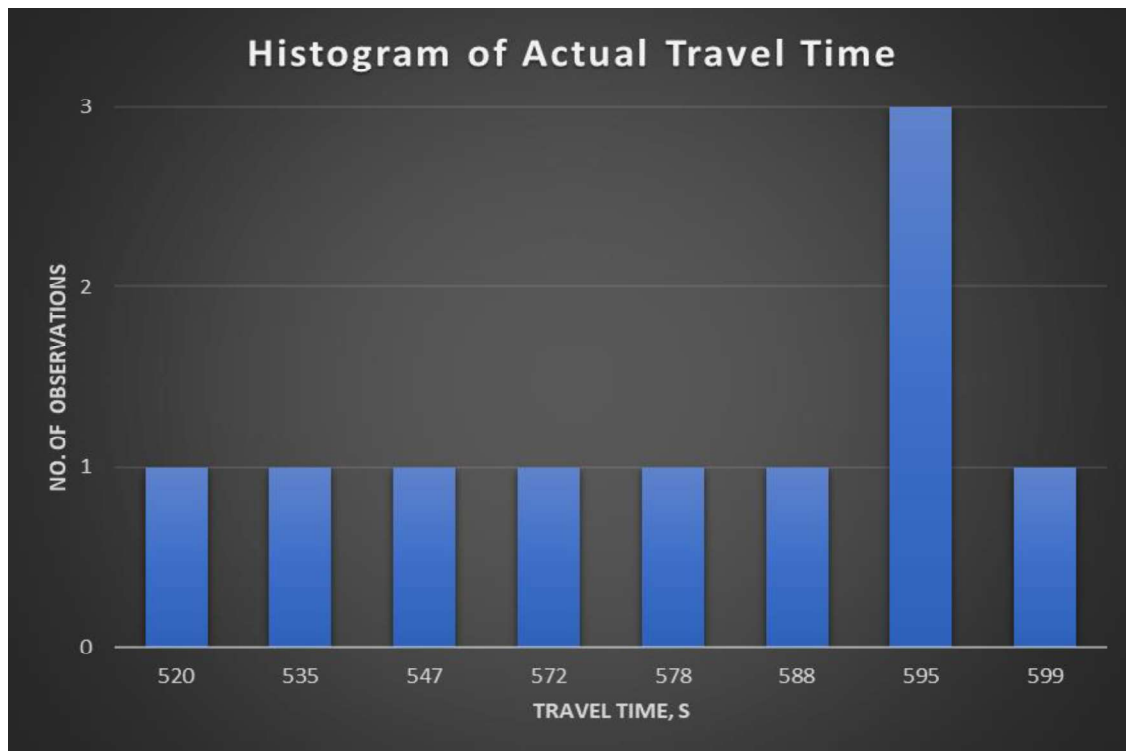


Figure 3 Histogram of Actual Travel Time Data

For intersection delay study, an intersection at Milestone Point 5 was chosen. The analysis is shown below:

Intersection at MP 5									
Location: E Lincoln St.									
Clock Time	Cycle Number	Number of Vehicles in Queue			ΣV_{iq}	VT	Vstop	Free Flow Speed, mi/hr	Average time in queue, s/veh
		+0 secs	+25 secs	+50 secs					
3:00 PM	1	3	6	2	172	148	102	30	26.15
3:02 PM	2	6	6	1					
3:04 PM	3	5	3	4					
3:06 PM	4	1	3	3					
3:08 PM	5	2	2	2					
3:10 PM	6	1	5	1					
3:12 PM	7	6	4	3					
3:14 PM	8	4	4	2					
3:16 PM	9	1	2	1					
3:18 PM	10	2	7	5					
3:20 PM	11	2	6	3					
3:22 PM	12	7	7	1					
3:24 PM	13	6	4	1					
3:26 PM	14	6	6	6					
3:28 PM	15	1	4	1					
3:30 PM	16	5	7	2					
Total		58	76	38					

From the above signalized intersection delay study above, the average time in queue, T_q , adjustment factors and total control delay were found out.

No. of lanes in survey lane	2
No. of cycles in survey	16
VSLC, veh/lane/cycle	3.188
Fraction of Vehicles stopping, FVS	0.69
Correction Factor, C.F	5
Total Control Delay, d (sec)	31.84

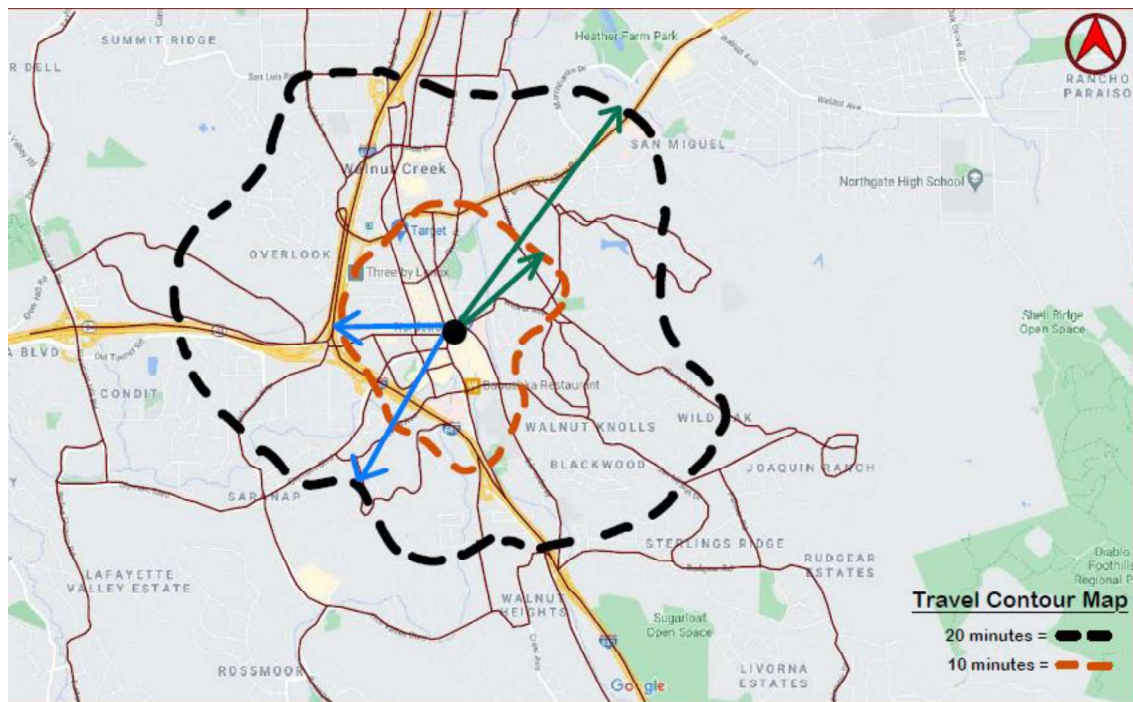


Figure 4 Travel Time Contour Map of a small town

Crash Studies and Statistics

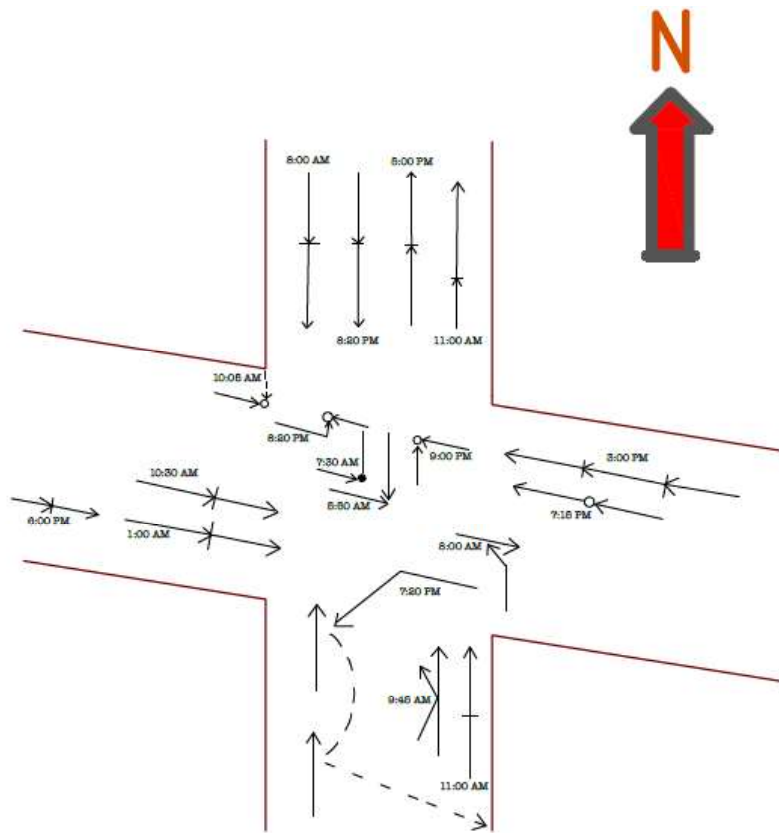
Crash study analysis are important for all countries since the results represent the country's road infrastructure condition and how safe the transportation network is. It also indicates how developed a country is, so, in this study, two countries were chosen one of which was USA (a developed country) and the other one was Argentina (a developing country). The results are summarized in the following tables:

Crash Statistics in USA for 2018			
Fatalites	36,835	Rate 1 (deaths per 100,000 population)	11.26
Fatal Accidents	33,654		
Injury Accidents	1,894,000	Rate 2 (deaths per 10,000 registered vehicles)	1.35
PDO Accidents	4,807,000		
Total involments	6,734,000	Rate 3 (deaths per 100,000 licensed drivers)	16.19
Vehicle-Miles Traveled	269,700,000,000		
Registered Vehicles	273,600,000	Rate 4 (deaths per 1,000,000,000 veh-mi)	136.58
Licensed Drivers	227,558,385		
Area Population	327,200,000	Severity Index	0.005469

Crash Statistics in Argentina for 2018			
Fatalites	5,493	Rate 1 (deaths per 100,000 population)	12.34
Fatal Accidents	3,588		
Injury Accidents	888,901	Rate 2 (deaths per 10,000 registered vehicles)	2.24
PDO Accidents	1,943,000		
Total involments	2,835,489	Rate 3 (deaths per 100,000 licensed drivers)	-
Vehicle-Miles Traveled	98,700,000,000		
Registered Vehicles	24,500,000	Rate 4 (deaths per 1,000,000,000 veh-mi)	55.65
Licensed Drivers	-		
Area Population	44,500,000	Severity Index	0.001937

Collision Diagrams

An integral part of the study of dangerous highway locations is collision diagrams, which are graphical representations of accident experience at intersections or along roadway segments. In the figure below, a random a collision diagram of a random intersection is shown.



	Day	Night	Total
Fatal	1	0	1
Injured	1	3	4
PDO	6	6	12
	8	9	17

Parking Studies

To collect parking statistics such as parking accumulation, parking turnover, parking load, etc. parking surveys are performed. In-out surveys, fixed time polling and license plate survey methods are the most popular parking surveys performed. In the scenario of an ever-growing automobile population, the availability of appropriate parking spaces is a problem for traffic engineers and planners. In order to design the facilities or schedule the fares, it is necessary to conduct such surveys.

In our study, 6 blocks were chosen to be monitored and the number of slots in each block were between 1 to 4 with a survey duration of 8 hours (12 PM-8 PM). The location was at 1218-1280 W Encanto Blvd, Phoenix, AZ, United States. Our main goal of the study was to find the parking accumulation, average parking duration and parking turnover rate. The summary of the data collected is given below:

Parking Field Study Sheet																		
Block	Slot	Time																
		12:00 PM	12:30 PM	1:00 PM	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM	5:00 PM	5:30 PM	6:00 PM	6:30 PM	7:00 PM	7:30 PM	8:00 PM
1	1	-	156	✓	✓	-	657	-	532	✓	✓	✓	678	✓	345	-	126	✓
	2	453	-	789	✓	-	-	457	298	✓	564	-	546	225	✓	✓	987	-
	3	342	-	-	037	✓	✓	-	641	-	-	758	✓	-	710	304	-	216
2	1	319	✓	895	✓	835	555	✓	✓	845	✓	-	-	105	956	✓	✓	808
	2	-	342	✓	163	-	661	✓	094	✓	-	349	342	✓	-	034	-	179
3	1	-	384	✓	✓	✓	013	✓	622	-	819	-	531	-	751	333	✓	-
	2	-	743	✓	513	-	-	759	✓	342	314	-	046	✓	342	-	365	✓
4	2	342	-	952	✓	342	-	274	495	✓	-	475	✓	342	810	✓	255	-
	3	-	346	121	502	✓	570	384	✓	654	-	474	-	-	925	-	666	008
	4	783	✓	-	-	534	✓	-	-	450	✓	-	342	✓	342	✓	207	-
5	1	290	✓	342	-	928	-	442	✓	250	-	-	-	290	✓	-	-	966
	2	-	947	-	011	✓	709	✓	-	446	-	-	943	✓	-	837	342	-
6	1	-	342	-	821	-	-	359	260	✓	064	984	-	646	-	387	-	-
	2	959	✓	-	099	✓	342	✓	-	867	-	-	773	✓	✓	287	-	748

Parking Summary Sheet																		
Block	Slot	Time																
		12:00 PM	12:30 PM	1:00 PM	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM	5:00 PM	5:30 PM	6:00 PM	6:30 PM	7:00 PM	7:30 PM	8:00 PM
1	2	1	2	3	1	2	1	3	2	2	2	3	2	3	2	2	1	
2	1	2	2	2	1	2	2	2	2	1	1	1	2	1	2	1	2	
3	0	1	1	1	1	1	1	1	0	1	0	1	0	1	1	1	0	
4	2	3	3	3	3	2	3	3	4	2	2	3	3	4	2	4	2	
5	1	2	1	1	2	1	2	1	2	0	0	2	2	1	1	1	1	
6	1	2	0	2	1	1	2	1	2	1	1	1	2	1	2	0	1	
TOTAL	7	11	9	12	9	9	11	11	12	7	6	11	11	11	10	9	7	

Data Analysis

Using the parking field study and summary, the parking turnover rate and the average duration of the parking was calculated. The total duration of the survey was 8 hours.

Parking Location		1218-1280 W Encanto Blvd, Phoenix, AZ, United States	
Time Interval			
1	2	3	4
44	39	6	2
91			
Length of interval, hour		0.5	
Average parking duration, D, (h/veh)		0.81	
Total No. of Legal Parking Spots		14	
Total Duration of Study, h		8	
Parking Turnover Rate, veh/stall/h		0.813	

Results and Discussion

In travel time and delay studies, for the road, E Lincoln St., the mean running time for 10 runs was found out to be 486.7 seconds and average travel time considering the signal time was 510.63 seconds. From the histogram, we can observe that 3 trips took around 595 seconds, whereas, the other travel times occurred only once. Also, if we compare the average speed before and after considering delay, we can observe that average speed was almost lower by 1 mi/hour during the delay. So, the studies indicate that the road has moderate traffic and is located in an urban area.

Intersection delay study was performed for 30 minutes with two minutes intervals and the road consisted of two lanes. The total number of vehicles were 172 and most vehicles spent around 27 seconds in the queue. Finally, the total control delay was 31.84 seconds.

The crash statistics of both the countries, USA and Argentina, show some differences mainly due to the number of vehicles registered, population and registered vehicles. Since, the population and registered vehicles in both the countries vary significantly, the comparison might not be standard. However, if we observe the deaths per 100,000 population, USA has a lower ratio than Argentina and it is similar in the case of deaths per 10,000 registered vehicles. This difference could be due to better road infrastructures, rules and regulations and a more educated nation.

The parking study consisted of 6 blocks and the total number of vehicles parked was 91. The parking turnover rate was found out to be 0.813, which is quite low. It means the parking area was not being utilized properly and more revenue could have been earned if it had increased utilization.