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Los Angeles Congested Corridor Study and Comparisons with Texas Transportation Institute Congestion Estimates

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Abstract

The urban mobility report and congested corridors report by Texas Transportation Institute (TTI) are the best known congestion studies in the United States. The data source TTI uses, however, limits the accuracy and reliability of the reported measures. The low resolution speed dataset and arbitrarily distributed volume profile could lead to considerable errors for both reliability and total congestion measures. In this paper, we evaluate the degree of measuring improvement by applying our high resolution traffic speed and volume data collected from the entire Los Angeles County highways. Our study shows the TTI report underestimates peak hour unreliability and overestimates total congestion. The estimated planning time indexes and buffer indexes on the 28 congested corridors studied are 18 percent and 51 percent greater than the TTI report respectively. Annual delays and congestion costs are only two-thirds of the TTI estimates. This case study highlights the need to improve the TTI estimates for it to be a best decision basis for planners, drivers and researchers. It is also found the keys to improve these congestion measures are a high temporal resolution speed dataset and a nationwide real-world traffic volume dataset.

Keywords
Texas Transportation Institute, Los Angeles congested corridor, traffic reliability, delay and congestion cost, real world traffic database

1. Introduction

The last several decades have seen a steady growth of traffic demand. The supply side has experienced much less growth. This has resulted in increased traffic congestion. Congestion measures help planners identify the most critical problems and support decision makers in choosing congestion relief strategies. Total measures (including hours of delay, gallons of fuel wasted and congestion cost) help to identify the most congested cities and the critical corridors responsible for the greatest delays and wastes during peak and off-peak hours. Peak measures (including peak period delay, buffer index, planning time index and travel time index) can enable regular drivers to assess traffic reliability and to plan accordingly.

The best known urban mobility and congested corridors report is published by the Texas Transportation Institute (TTI) [1,2]. The congestion measures from TTI have been widely used to evaluate congestion for large metropolitan areas in the US. Policy makers rely on TTI's reports to compare and rank congestion levels in major metropolitan areas. TTI has had substantial impact on the decision making behind transportation related projects and funding distributions. The congestion rankings of metropolitan areas and corridors have also been widely cited by popular media. TTI's metropolitan area congestion rankings conceivably influence business and public group's evaluation and selection of business and residence locations. Truck drivers as well as other regular travelers also reference TTI congestion corridor rankings in their route selection.

The TTI reports have been cited in various scholarly books and journals. Many researchers use the TTI reports as a key source of evidence on traffic and infrastructure performance. Anthony Downs' widely cited book [3] used the TTI data as the basis for a whole chapter – "How Bad is Traffic Congestion," because "they are the only measures available that cover many different regions over long periods using the same basic methods in each region". The most cited data from TTI's reports are the travel time indexes, annual delays and congestion costs. These are referenced in Kockelman and Kalmanje [4], Parry et al. [5] as well as Ewing et al. [6]. A well known article by Glaeser and Kohlhase [7] relied on TTI's 1980-2000 trend data to support the conclusion that the cost of moving people continues to dominate urban transport costs.

The accuracy of the total and peak measures in the congestion reports is however, limited. Hourly traffic volumes are generated by multiplying annual traffic counts by an hourly adjustment factor. And a one-week hourly speed dataset, supported by INRIX, is used to estimate annual peak and total measures. Taylor [8] argued that TTI overestimates congestion costs. This conforms to the Los Angeles case study reported here, which shows the total congestion cost for congested corridors is only two-thirds of the estimates by TTI.

The key to an accurate congestion measure is speed and volume data (Memmott, [9]). The advancement of Intelligent Transportation Systems (ITS) in the US provides the potential to improve congestion measures. A survey (Gordon, [10]) of 78 large metropolitan areas by the Research and Innovative Technology Administration (RITA) of USDOT in 2010 found that the percentage of freeway miles with real-time traffic data collection technologies increased from 18 percent in 2000 to 55 percent in 2010. Of the 122 freeway management agencies surveyed, about 70 percent collected and archived real-time traffic volume and speed data in 2010. Of the 290 arterial management agencies surveyed, 40 percent collected and archived traffic volumes and 22 percent archived traffic speeds. To make the best use of ITS, the data should be archived and aggregated in a well-managed database.

The Integrated Media System Center (IMSC) at the University of Southern California, in collaboration with Los Angeles County Metropolitan Transportation Authority (LA Metro), maintains a wide-area, large-scale, and high resolution (both spatially and temporally) Archived Data Management System (ADMS) that includes traffic sensor (i.e., loop detector) data set collected from the entire network of Los Angeles County highways and arterial streets of Los Angeles City. The datasets, acquired through Regional Integration of Intelligent Transportation System (RIITS) [11], include both a physical inventory of sensors and real-time data updated as frequently as every minute for 6,300 traffic sensors covering approximately 3,000 miles. The sampling rate of this streaming data is one reading/sensor/min. IMSC has been continuously collecting and archiving these traffic sensor data over the past two years.

With this database we are able to create more accurate congestion measures for Los Angeles' congested corridors. A comparison with the TTI congested corridors report shows the TTI report overestimated total congestion and underestimated travel unreliability. The unreliability (95^{th} percentile travel time) compared to free flow is 18 percent greater than the measure reported by TTI, and the unreliability compared to average flow is 51 percent greater than the TTI report. Moreover, the annual delays are 37 percent less than the TTI report, and total annual congestion costs are 32 percent less than the TTI report. These differences can make a substantial difference on assessments and the decision making of policy makers and vehicle drivers. These findings also highlight the significance of managing well-organized traffic database for large metropolitan areas.

The remainder of this paper is organized as follows. Congestion measures by the Federal Highway Administration (FHWA) and TTI data and methodologies are reviewed in Section 2. In Section 3, we present our results on congestion measures and traffic patterns for 28 Los Angeles area corridors. We discuss the implications for policy makers and vehicle drivers in Section 4 to conclude this paper.

2. Congested Measure Overview

Travelers are least tolerant of unexpected delays. Accurate congestion measures help drivers plan sufficient slack time to accommodate unusual traffic. The most used reliability indexes are 90th or 95th percentile travel times, buffer index, planning time index and travel time index. Federal Highway Administration (FHWA) [12] defines these indexes as:

- Buffer index represents the extra time that travelers must add to their average travel time when planning trips to ensure on-time arrival. For instance, if the 95th percentile buffer index is 0.4 and average travel time is 20 minutes, then buffer time = 20 minutes × 0.4 = 8 minutes. The 8 extra minutes is called the buffer time.
- Planning time index represents how much total time a traveler should allow to ensure on-time arrival. For example, if the 95th percentile planning time index is 1.60 and the free-flow travel time is 15 minutes, then planning time = 15 minutes × 1.60 = 24 minutes.
- Travel time index is a measure of average condition that tells one how much longer, on average, travel time is during congestion compared to during light traffic. For instance, if travel time index is 1.30 and free-flow travel time is 20 minutes, then average travel time = 20 minutes × 1.30 = 26 minutes.

2.1 TTI Methodology

The TTI report calculates a 95th percentile buffer index, 95th percentile planning time index and travel time index during the peak hours. The morning peak is from 6 a.m. to 10 a.m. and the evening peak is from 3 p.m. to 7 p.m.

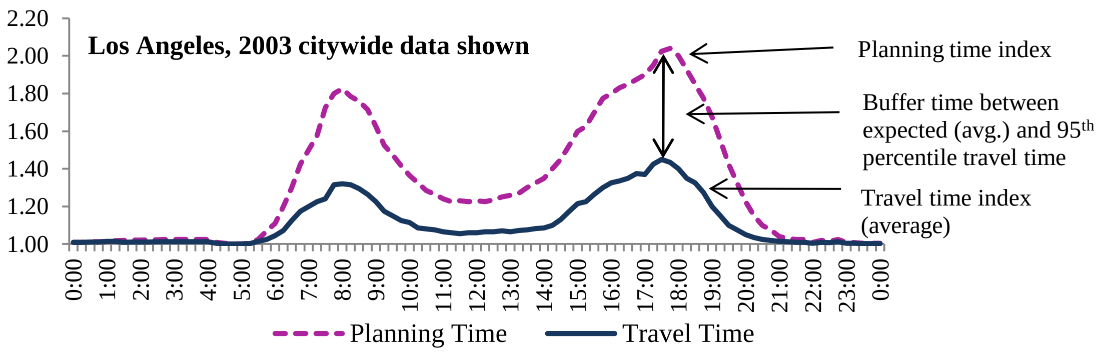

Figure 1: Reliability measures compared to average congestion measures.
(Source: http://mobility.tamu.edu/mmp)

Another set of congestion measures are total measures including annual person-hours of delay, fuel wasted and congestion cost. These total measures aggregate delays or fuel wastes 24 hours a day and 7 days a week. Delay is the real travel time minus free-flow travel time. Fuel wasted includes passenger vehicle and truck wasted fuel. Congestion cost includes fuel wasted and delay cost. The average costs of delayed time for passengers and commercial vehicles are estimated based on past research by McFarland and Chui [13] and Ellis [14]. Fuel wasted is the difference between actual fuel consumed and fuel consumed if traffic is free-flow. Regression equations based on fuel efficiency data from EPA/FHWA's MOVES model [15] are used to estimate passenger car and truck fuel economy. The passenger car fuel economy and truck fuel economy are calculated using equation (1) and (2):

$$\text{Passenger Car Fuel Economy} = 0.0066 \times speed^2 + 0.823 \times \text{speed} + 6.1577 \quad (1)$$

$$\text{Truck Fuel Economy} = 1.4898 \times \ln(speed) - 0.2554 \quad (2)$$

2.2 TTI Data Source

TTI uses a one-week hourly speed dataset from INRIX. INRIX collects traffic speed data from public and private sources, including traditional road sensors, GPS-enabled vehicles and mobile devices. This does not ensure continuity and completeness of the speed data on specific corridors. Thus sophisticated statistical analysis techniques originally developed by Microsoft Research are used to aggregate and enhance the speed information.

In the TTI report, hourly volume is estimated from annual traffic counts by multiplying Average Daily Traffic (ADT) with an adjustment factor based on the time of day and day of the week. Eight different traffic distribution profiles are used: weekend, weekday low congestion AM peak, weekday low congestion PM peak, weekday moderate congestion AM peak, weekday moderate congestion PM peak, weekday severe congestion AM peak, weekday severe congestion PM peak, weekday severe congestion AM and PM peak. The traffic distribution profiles are developed based on 713 traffic monitoring locations in urban areas of 37 states. The detailed methodology can be found in the TTI urban mobility and congested corridors reports.

3. Congestion Measure and Traffic Pattern

In this section, we present our peak measures and total measures estimated using the ADMS database. A discussion about the IMSC and TTI data quality is made in Section 3.1. Comparisons with the TTI congestion report are shown in Table 2, Table 3 and Figure 3. Two major findings from these comparisons are discussed in Section 3.2 and Section 3.3.

3.1 Keys to Accurate Congestion Measures

To estimate total and peak congestion measures, two important inputs are traffic speed and volume. Speed information is the most important input for peak measures as well as total measures. Even a 10 percent difference in the speed input can sometimes lead to a 30 to 40 percent deviation in these measures. Volume information directly affects total measures in the sense that delays and fuel wasted are proportional to the traffic volume. Volume information also plays an important role for peak measures since it adds distinct weights to these measures during different time of the day.

Another important aspect that affects measure accuracy is speed and volume resolution. This includes resolution over time and resolution over lane-miles. Speed resolution over time has the highest impact on peak measures. Peak measures like planning time index capture extreme congested situations. If speed is averaged hourly, important congestion information during the hour will be missed out. The resolution over lane-miles also has a large impact on accuracy. According to our observations, the congestion situation and speed may vary greatly for every 0.5 mile on a corridor.

With our ADMS database, we continuously collect speed and volume data as frequent as every one minute. This motivated us to make use of our traffic information and do a comparison with the TTI report. In this study, we retrieved traffic speed and volume data for a whole month (November 2011) for the 28 congested corridors studied in the Los Angeles region. Sensors that failed to function properly were preprocessed. We aggregated speed and volume data for every 15 minutes over this one month period. A comparison between the TTI and IMSC datasets are summarized in Table 1. These real-world high-resolution traffic data generated very consistent differences of traffic measures comparing with the TTI report. Details of the result and comparisons with the TTI congested report are shown in the following sub-sections.

Table 1: Comparisons between TTI and IMSC dataset.

	TTI datasets	IMSC datasets
Volume data	ADT ×hourly adjustment factor	ADMS sensor data, one reading/sensor/min
Speed data	INRIX speed data	ADMS sensor data, one reading/sensor/min
Timeframe	One week (yearly average)	One month (Nov. 2011)
Resolution over time	Annual volume count; aggregated speed data for each hour.	Aggregated speed and volume data (one reading/min) for every 15 min.
Resolution over lane-miles	Approximately 0.5 miles	Approximately 0.5 miles

3.2 Underestimated 95th Unreliability Measures (Buffer Index and Planning Time Index)

It is obvious from Table 2 and Figure 3 that buffer indexes and planning time indexes of the TTI report tend to be smaller than our estimates. The primary reason is the temporal resolution of the speed dataset used. The dataset in the TTI report is a one-week hourly average speed dataset from INRIX. The hourly average assumes that speed during the whole hour is uniform while there are actually some extreme conditions during any hour which are not captured. An example using our sensor data is shown in Figure 2. Lower time resolution smooth out extreme conditions and lead to an underestimation of unreliability measures. In this example, the 95th planning time index is 2.75 and buffer index is 0.55 when speed is aggregated for each 15 minutes. These measures decrease to 2.43 and 0.37 respectively when speed is aggregated hourly. This is a 12 percent decrease for planning time index and 33 percent decrease for buffer index. Moreover, the short time span (one week) of the TTI speed dataset also smooths out extreme congested conditions that happened during the year. All these factors drive the unreliability indexes down.

There are also a few cases where the planning time indexes reported by TTI are larger than those by IMSC. This could be because the estimated traffic volumes during peak hours in the TTI report tend to be higher than real world traffic volume for Los Angeles congested corridors. More details about the traffic volume estimation are discussed in the next sub-section.

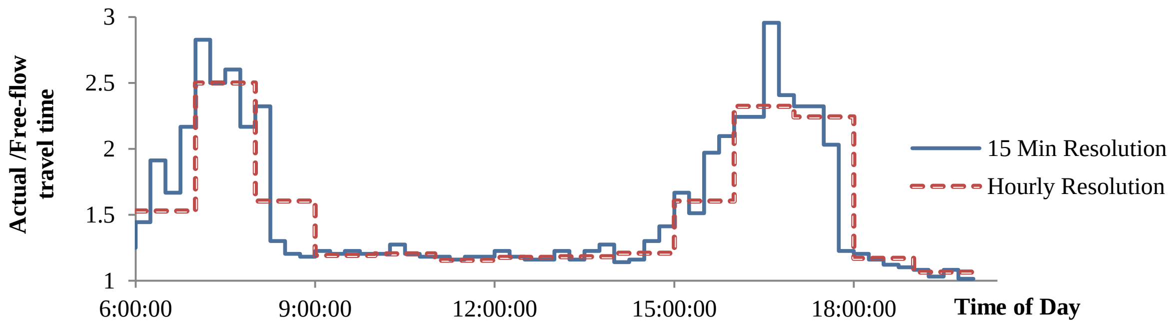

Figure 2: The ratio of actual travel time over free flow travel time when speed is aggregated for each 15 minutes and each hour respectively. (Source: ADMS traffic sensor data.)

Table 2: Comparisons of IMSC and TTI peak measures. Avg(+) / Avg(-) is the average of the rows with a positive / negative difference.

			Buffer Index			Planning Time Index			Travel Time Index		
		Length(mile)	TTI	IMSC	Difference	TTI	IMSC	Difference	TTI	IMSC	Difference
1	I-710 NB	3	1.33	1.44	**8%**	3.83	5.19	**36%**	1.7	2.07	**22%**
2	I-5 SB	12.6	1.14	1.14	**0%**	2.92	4.06	**39%**	1.54	1.89	**23%**
3	Pomona Fwy/CA-60 WB	10.4	0.98	1.63	**66%**	3.47	5.27	**52%**	1.69	1.98	**17%**
4	Century Fwy/I-105 EB	17.6	0.94	0.86	**-8%**	3.42	3.63	**6%**	1.8	1.85	**3%**
5	I-710 SB	3.7	0.9	0.65	**-28%**	4.19	2.48	**-41%**	2.1	1.44	**-31%**
6	Orange Fwy/CA-57 NB	14.7	0.86	1.08	**25%**	3.5	2.58	**-26%**	1.88	1.24	**-34%**
7	I-5 NB	22.5	0.86	0.90	**5%**	3.07	3.70	**21%**	1.92	1.88	**-2%**
8	San Diego Fwy/I-405 NB	13.1	0.82	1.25	**52%**	3.97	3.47	**-13%**	2.65	1.51	**-43%**
9	CA-134 EB	3.1	0.81	1.27	**57%**	3.38	4.19	**24%**	1.84	1.86	**1%**
10	I-5 NB	5.8	0.81	0.92	**14%**	2.64	2.79	**6%**	1.46	1.46	**0%**
11	US-101 SB	26.7	0.8	1.12	**40%**	3.32	3.87	**16%**	1.85	1.81	**-2%**
12	US-101 NB	21.5	0.8	0.98	**22%**	3.26	3.87	**19%**	1.85	1.92	**4%**
13	I-605 SB	4.8	0.76	0.66	**-13%**	3.64	2.57	**-29%**	2.34	1.53	**-35%**
14	Foothill Fwy/I-210 EB	17.2	0.74	0.81	**9%**	3.17	2.59	**-18%**	1.84	1.43	**-22%**
15	I-405 NB	9.5	0.73	1.86	**155%**	2.53	6.98	**176%**	1.44	1.89	**31%**
16	Harbor Fwy/I-110 NB	6.5	0.7	1.27	**81%**	2.97	4.55	**53%**	2.51	2.01	**-20%**
17	I-605 NB	5	0.69	0.76	**11%**	3.33	2.50	**-25%**	1.86	1.37	**-26%**
18	US-101 SB	4.4	0.69	0.07	**-89%**	2.55	1.06	**-59%**	1.46	0.98	**-33%**
19	CA-91 EB	6.7	0.68	1.24	**82%**	3.26	3.84	**18%**	1.89	1.72	**-9%**
20	I-405 NB	7.3	0.66	1.03	**56%**	2.78	2.91	**5%**	1.63	1.42	**-13%**
21	Santa Monica Fwy EB	14.9	0.65	2.84	**337%**	3.6	7.65	**112%**	2.31	2.02	**-13%**
22	Pomona Fwy/CA-60 EB	21.7	0.64	0.87	**36%**	3.14	2.93	**-7%**	1.82	1.54	**-15%**
23	I-210 WB	5.5	0.64	1.39	**117%**	2.69	3.72	**38%**	1.6	1.56	**-2%**
24	I-10 WB	5.2	0.6	1.26	**110%**	2.69	3.91	**45%**	1.66	1.73	**4%**
25	San Diego Fwy/I-405 SB	8.1	0.53	1.14	**114%**	2.97	3.92	**32%**	2.06	1.83	**-11%**
26	I-10 WB	6.4	0.5	0.62	**24%**	2.56	2.00	**-22%**	1.62	1.24	**-24%**
27	Century Fwy/I-105 WB	12.5	0.46	0.87	**89%**	2.42	3.90	**61%**	1.59	2.03	**28%**
28	I-5 NB	3.3	0.44	0.69	**57%**	2.43	2.33	**-4%**	1.9	1.38	**-28%**
				Avg(+)	**68%**		Avg(+)	**42%**		Avg(+)	**13%**
				Avg(-)	**-35%**		Avg(-)	**-24%**		Avg(-)	**-20%**
				Avg.	**51%**		Avg.	**18%**		Avg.	**-8%**

Table 3: Comparisons of IMSC and TTI total measures. Avg(+) / Avg(-) is the average of the rows with a positive / negative difference.

			Delay of Person-hours (*1000)			Gallons Wasted (*1000)			Congestion Cost (*1000)		
		Length(mile)	TTI	IMSC	Difference	TTI	IMSC	Difference	TTI	IMSC	Difference
16	Harbor Fwy/I-110 NB	6.5	1126	366	**-67.50%**	3665	1655	**-54.84%**	158173	54247	**-65.70%**
8	San Diego Fwy/I-405 NB	13.1	965	197	**-79.59%**	6057	1824	**-69.89%**	269925	58872	**-78.19%**
13	I-605 SB	4.8	681	225	**-66.96%**	1664	799	**-51.98%**	70454	24760	**-64.86%**
21	Santa Monica Fwy/I-10 EB	14.9	640	219	**-65.78%**	4664	2093	**-55.12%**	203998	73744	**-63.85%**
29	CA-110 SB	6.6	526	457	**-13.12%**	1679	2257	**34.43%**	73700	69253	**-6.03%**
12	US-101 NB	21.5	503	354	**-29.62%**	5386	5361	**-0.46%**	232387	172743	**-25.67%**
7	I-5 NB	22.5	487	358	**-26.49%**	5442	5772	**6.06%**	235356	184114	**-21.77%**
11	US-101 SB	26.7	485	299	**-38.35%**	6262	5646	**-9.84%**	277732	182189	**-34.40%**
25	San Diego Fwy/I-405 SB	8.1	458	234	**-48.91%**	1793	1357	**-24.32%**	79085	43404	**-45.12%**
17	I-605 NB	5	423	137	**-67.61%**	1038	489	**-52.89%**	44997	15678	**-65.16%**
28	I-5 NB	3.3	388	109	**-71.91%**	641	260	**-59.44%**	27533	8244	**-70.06%**
14	Foothill Fwy/I-210 EB	17.2	363	133	**-63.36%**	3073	1692	**-44.94%**	132885	52600	**-60.42%**
5	I-710 SB	3.7	359	121	**-66.30%**	649	324	**-50.08%**	27869	10234	**-63.28%**
22	Pomona Fwy/CA-60 EB	21.7	357	235	**-34.17%**	3828	3737	**-2.38%**	165020	116787	**-29.23%**
6	Orange Fwy/CA-57 NB	14.7	321	64	**-80.06%**	2260	656	**-70.97%**	100145	21437	**-78.59%**
24	I-10 WB	5.2	317	201	**-36.59%**	786	762	**-3.05%**	35294	23987	**-32.04%**
1	I-710 NB	3	299	313	**4.68%**	437	636	**45.54%**	19195	21309	**11.01%**
3	Pomona Fwy/CA-60 WB	10.4	281	327	**16.37%**	1374	2345	**70.67%**	62000	77446	**24.91%**
26	I-10 WB	6.4	274	63	**-77.01%**	839	153	**-81.76%**	37490	9342	**-75.08%**
20	I-405 NB	7.3	274	143	**-47.81%**	859	748	**-12.92%**	42017	23888	**-43.15%**
4	Century Fwy/I-105 EB	17.6	272	236	**-13.24%**	2208	2805	**27.04%**	102055	94160	**-7.74%**
23	I-210 WB	5.5	264	156	**-40.91%**	689	619	**-10.16%**	30873	19596	**-36.53%**
9	CA-134 EB	3.1	258	207	**-19.77%**	384	468	**21.88%**	16734	14718	**-12.05%**
2	I-5 SB	12.6	254	308	**21.26%**	1488	2776	**86.56%**	68161	88687	**30.11%**
27	Century Fwy/I-105 WB	12.5	215	335	**55.81%**	1143	2949	**158.01%**	56633	95569	**68.75%**
10	I-5 NB	5.8	166	112	**-32.53%**	430	464	**7.91%**	20620	14854	**-27.96%**
15	I-405 NB	9.5	147	228	**55.10%**	638	1185	**85.74%**	29550	48171	**63.02%**
18	US-101 SB	4.4	147	7	**-95.24%**	298	19	**-93.62%**	13833	719	**-94.80%**
				Avg(+)	**30.65%**		Avg(+)	**54.38%**		Avg(+)	**39.56%**
				Avg(-)	**-51.43%**		Avg(-)	**-41.59%**		Avg(-)	**-47.90%**
				Avg	**-37%**		Avg	**-7%**		Avg	**-32%**

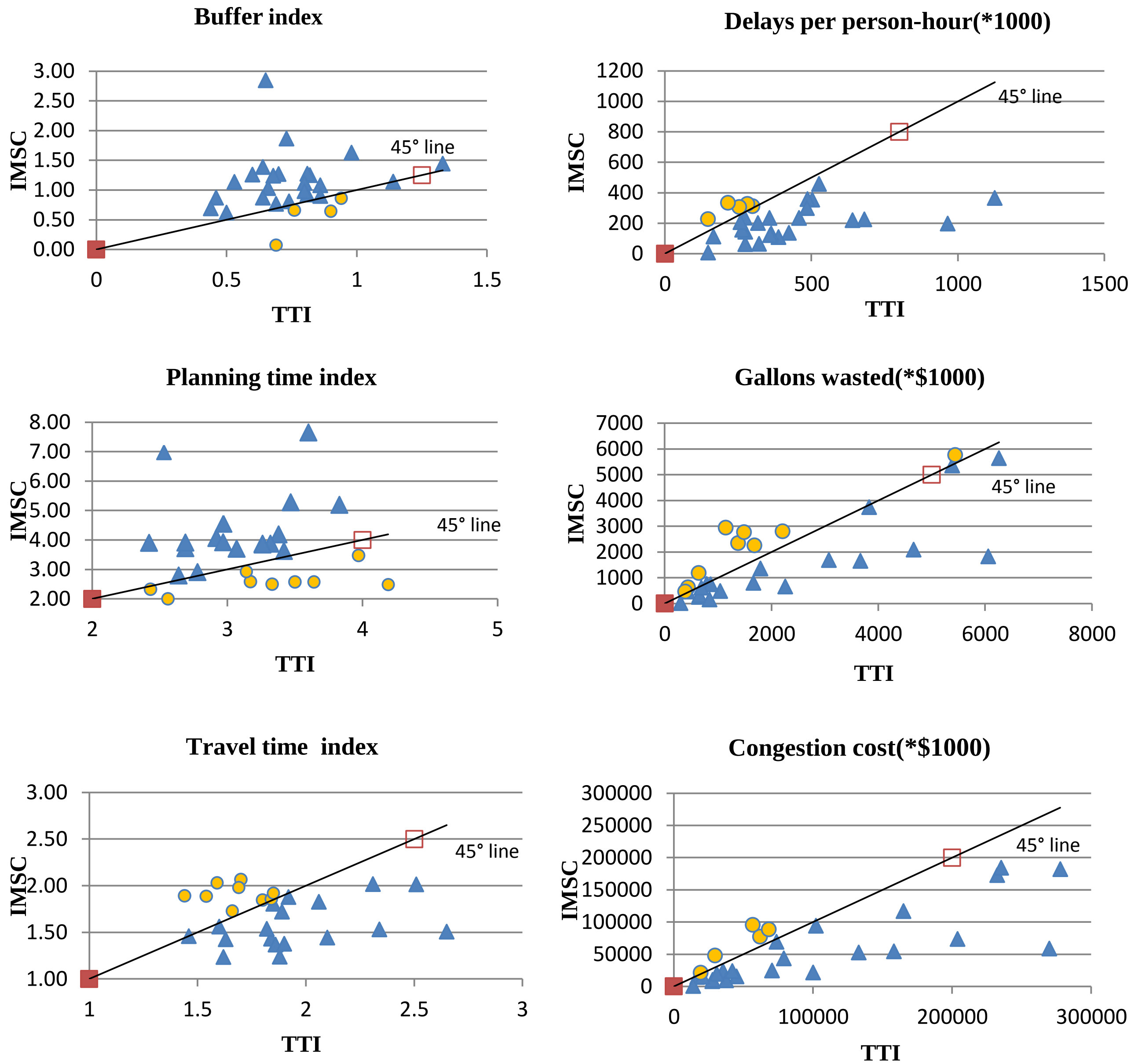

Figure 3: Scatter plots of the TTI measures compared with the IMSC measures. The straight lines in the scatter plots indicate where measures by TTI equal measures by IMSC. Total number of data points in each table is 28. The triangle points show the side of the deviation where most observations are.

3.3 Overestimated Travel Time Index and Total Measures (Delay of person-hours, Gallons Wasted and Congestion costs)

In contrast to the unreliability measures, traffic measures that evaluate the overall congestion tend to be overestimated. An important cause of this discrepancy is the arbitrary distribution of hourly traffic volumes in the TTI report. The traffic distribution used in the TTI report represents a national average and can approximate real world traffic volume in a certain degree. However, when it comes down to specific cases, the discrepancy can lead to considerable estimation errors. The distribution curves tend to have very high traffic volume during the most congested hour, for instance 7 a.m. - 8 a.m., which does not conform to the traffic condition in Los Angeles. Most congested corridors in Los Angeles are severely congested during AM, PM or both. During off peak hours, most corridors are also highly saturated. According to our analysis of the volume data, the peak hour volumes are almost uniform across the peak hours on the 28 congested corridors studied. Figure 4 shows distributions of traffic volumes by a sensor on the I-5 freeway and by the "weekday severe congestion AM peak" distribution in the TTI report. In this example, the travel time index and delay estimated by the arbitrary distribution are 21 percent and 24 percent lower than the real values respectively. This example shows continuously collected real world traffic volume data can improve the travel time index and total measures in the TTI report substantially.

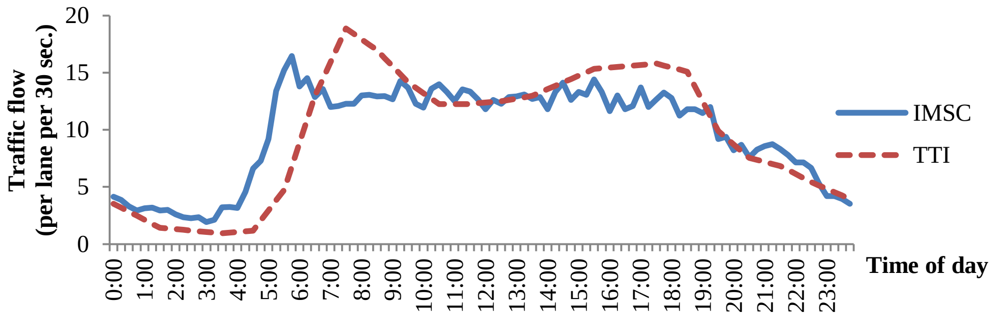

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Figure 4: Distribution of traffic volume on an AM peak corridor on the I-5 freeway. The blue line shows the traffic flow by sensor data. The red line is the arbitrary distribution used in the TTI report. (Source: AMDS traffic sensor data and the 2011 Congested Corridors Report [2].)

4. Discussion and Conclusion

As the only national metropolitan congestion study, the TTI urban mobility reports and congested corridors reports are widely cited and have been a guide for policy makers and vehicle operators. Our Los Angeles congested corridors study shows that high resolution traffic speed and real world volume data can improve the accuracy of congestion measures substantially. Metropolitan areas with available traffic data collecting sensors should make use of their traffic database to produce more accurate estimates.

In the Los Angeles region, planners and drivers should expect traffic conditions to be less reliable than the TTI reports provide. There are more extreme congestion conditions than previously expected. Our estimated planning time indexes are 18 percent larger than the TTI estimates and buffer indexes are 51 percent larger than TTI reports. Drivers should be prepared to leave more slack time during peak hour trips.

For total measures, planners and drivers can expect the annual delay and total congestion cost to be around two thirds of the stated value from TTI. The overall congestion is much less than expected. This might also be the case for other US metropolitan areas. If not, Los Angeles might drop from the "most congested city in US".

Based on the consistent discrepancies shown in this study, it appears that the TTI estimates need to be improved to be the best basis for decisions about transportation related projects, business and residence location selection, truck and passenger driver route planning. This study highlights the importance of the following two key factors to improve the urban mobility and congested corridors study:

- Speed Resolution: other than hourly averaged speed data, a speed dataset that is aggregated each 15 minutes or 5 minutes can greatly improve the accuracy of unreliability measures including planning time index and buffer index.
- Real World Volume data: arbitrary distribution of traffic volume could lead to significant estimation errors. The advancement of ITS technology has enabled many traffic management agencies to collect and archive traffic volume data. Well-managed traffic database in major metropolitan area will greatly improve the quality of a nationwide urban mobility study.

We expect that with the new dataset available, the Urban Mobility Report and Congested Corridors Report will be able to give more consistent congestion study across the major metropolitan areas in the United States. This will provide planners, drivers and researchers the most reliable source of a nationwide traffic study.

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