Weekend Congestion Analysis

C9Y62 TWO 2

final

report

prepared for

Florida Department of Transportation

FTO FORECASTING & TRENDS OFFICE

August 2019

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1.0 Background

An often overlooked element of congestion analysis is the amount of congestion that occurs outside of the traditional weekday peak periods. The FDOT Source Book, for instance, reports speed-based mobility performance measures for non-holiday weekdays only. While typically thought to be of low consequence, anecdotal evidence suggests that weekend congestion is prevalent. While developing initial targets for System Performance measures to meet the Federal Transportation Performance Management guidelines, travel time reliability measures were examined for the weekend and weekday time periods. The preliminary results indicated that the weekend congestion on Interstates is rare while the same on non-Interstate NHS routes is very common.

2.0 Purpose

The purpose of this effort is to better understand weekend congestion dynamics on Florida's roadways, and thus (1) provide recommendations to incorporate weekend travel conditions while developing performance measures for The FDOT Source Book, and (2) consider the implications these findings have regarding the federal System Performance measures.

The study achieves the above purposes by analyzing:

- Travel time patterns for weekdays and weekends,
- Travel demand patterns for weekdays and weekends between 2010 and 2017, and
- Travel time performance measures, broken down by facility type, context classification, and population size.

3.0 Analysis

3.1 Travel Time Patterns

Travel time patterns on weekdays and weekends were analyzed for daily and peak periods for the entire state. These patterns indicate that peak period for travel on weekends typically occurs between Noon and 2 pm. Additionally, it was observed that roadway segments experience higher traffic congestion during weekend peak period than weekday peak period.

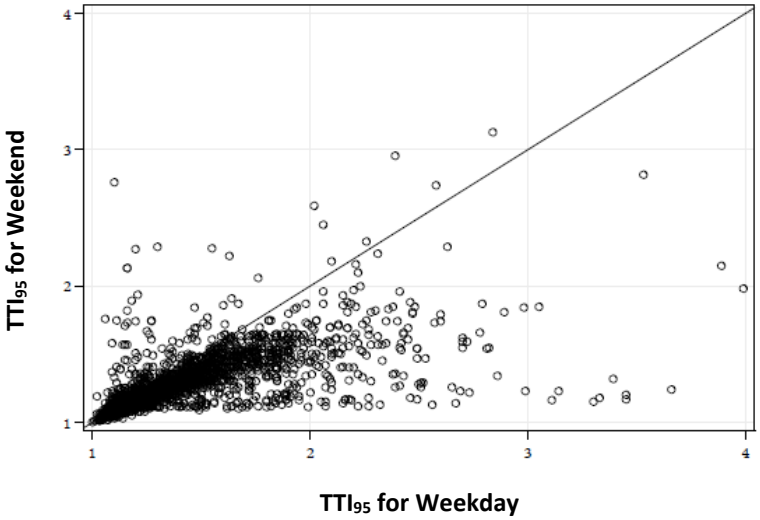
3.1.1 Daily Conditions Analysis

Figure 1 summarizes the 95th percentile travel index[1] (TTI_{95}), also known as Planning Time Index, during weekdays and weekends for various facilities across the state. To avoid extreme outlier data and results, these facilities were selected using continuous roadway segments whose length ranges between 2 miles and 10 miles. The analysis indicates that a significant majority of the facilities witness higher TTI_{95} during

[1] 95th percentile travel time index is the ratio of 95th percentile travel time to the free-flow travel time. Refer to the Section 3.3.1 on the definition of free-flow travel time. 95th percentile travel time index is the same measure as Travel Time Reliability: Planning Time Index, as included in The FDOT Source Book.

weekdays than weekends, on a daily basis. These results suggest greater unreliability during the weekdays on a 24-hour analysis period. To better understand the impact of weekend congestion, it is important to analyze travel patterns during peak period.

Figure 1 Comparison of Weekday and Weekend TTI_{95} – Daily Conditions

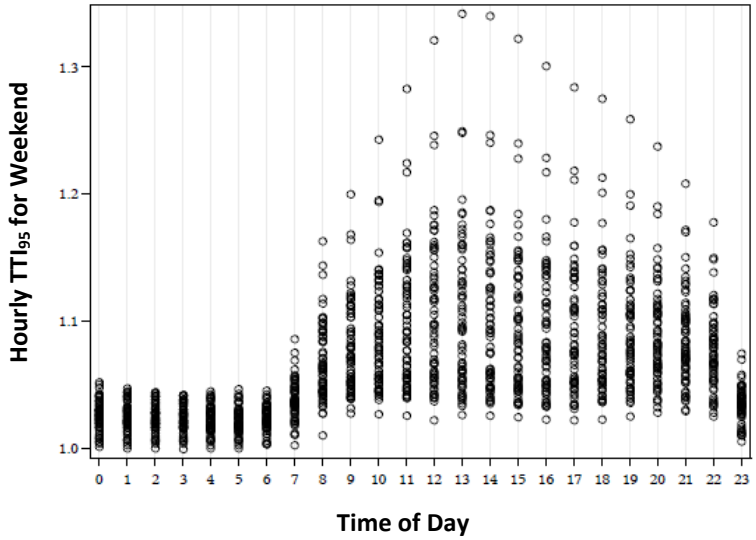


Note: º represents a facility with continuous roadway segments whose length ranges between 2 miles and 10 miles

3.1.2 Identification of Weekend Peak Period

For developing mobility performance measures, The FDOT Source Book identifies weekday peak period as occurring between 4 p.m. and 6 p.m. In order to identify the peak travel conditions on weekends, the TTI_{95} for each hour of the day for each of Florida's 67 counties were developed (**Figure 2**). The results indicate that the weekend travel times are usually high between 11 a.m. and 3 p.m. To be consistent with the 2 hour weekday peak period, a 2 hour weekend peak period between Noon and 2 p.m. was selected.

Figure 2 Weekend Hourly TTI_{95} – By County

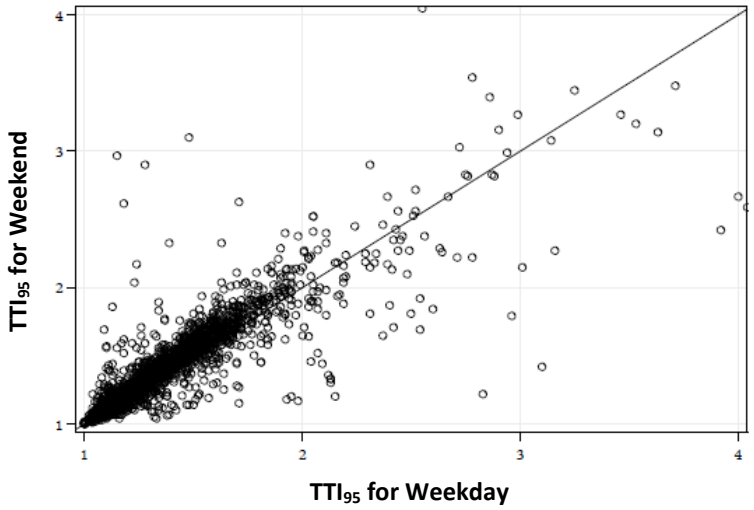


Note: º represents an hourly TTI_{95} value for each County

3.1.3 Peak Period Analysis

Figure 3 summarizes the TTI_{95} for peak periods during weekdays and weekends for various facilities across the state. Unlike the results for daily conditions, the results for peak period indicate that a majority of the facilities witness slightly higher TTI_{95} during weekends than weekdays. This analysis highlights the importance of accounting weekend peak period conditions in any statewide mobility performance measures development.

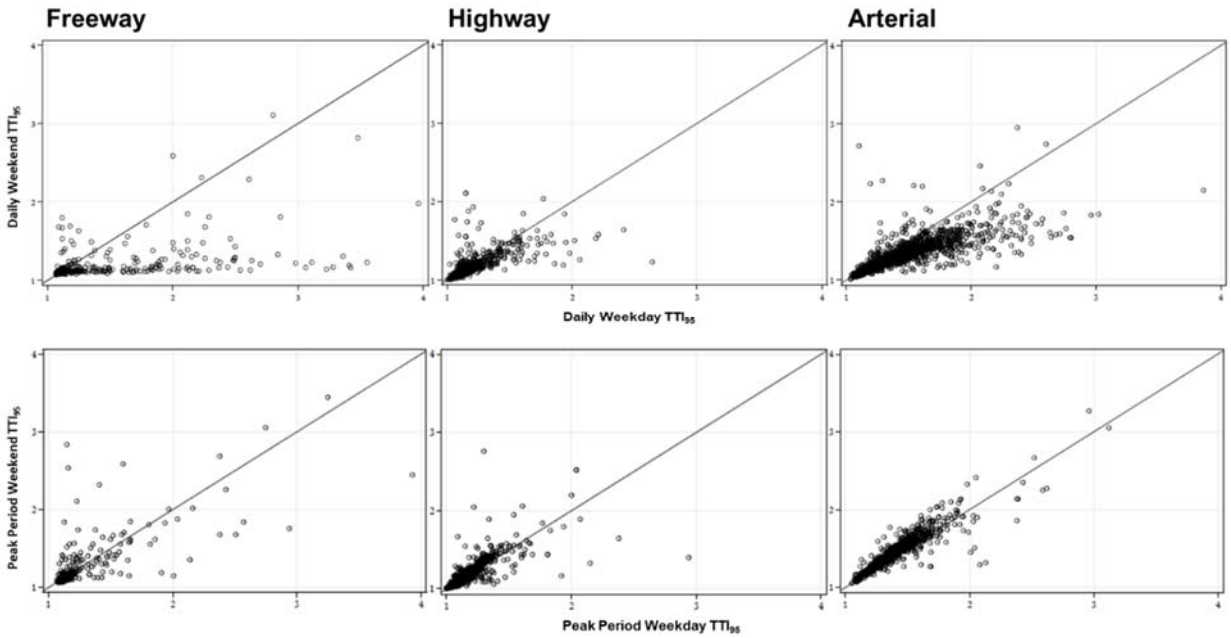
Figure 3 Comparison of Weekday and Weekend TTI_{95} – Peak Period Conditions



Note: º represents a facility with continuous roadway segments whose length ranges between 2 miles and 10 miles

Figure 4 shows the same daily vs. peak analysis but broken down by facility type. The upper half displays daily TTI_{95} comparisons, whereas the bottom half displays results for peak period. While all three facility types experience greater weekend congestion during peak period compared to daily, arterials experience this more – while highways barely show any difference going from daily to peak period. These results highlight the importance of accounting for weekend peak period conditions in any statewide mobility performance measures development.

Figure 4 Comparison of Weekday and Weekend TTI_{95} – Daily and Peak Period Conditions



3.2 Travel Demand

Historical travel demand along Florida's roadways was analyzed to determine how the weekday and weekend travel patterns changed over the years. Granular traffic volume data between 2010 and 2017 was obtained for each of the active continuous traffic monitoring sites maintained by FDOT. Currently, 230 permanent continuous vehicle count stations across the state collect volume, speed, and vehicle classification data and an additional 35 stations collect weigh-in-motion data 24 hours per day, 365 days per year.

Data from these sites was analyzed for daily and peak period conditions and broken down by facility type and area type. **Table 1** summarizes the travel demand patterns for daily and peak period conditions. The values in the table show average or typical daily and peak period traffic volume per counter.

Table 1. Travel Demand Patterns for Daily and Peak Conditions

				2010	2011	2012	2013	2014	2015	2016	2017	Annualized percent growth 2010-2017
Area Type	Urban	Daily	WD	23,703	23,359	23,543	24,109	24,912	25,469	27,021	28,526	2.9%
			WE	18,824	18,663	18,881	19,424	20,222	20,849	22,149	23,023	3.2%
		Peak	WD	3,631	3,576	3,631	3,735	3,826	3,853	4,053	4,240	2.4%
			WE	2,721	2,699	2,741	2,823	2,938	3,016	3,185	3,284	3.0%
	Non-Urban	Daily	WD	5,718	5,594	5,506	5,490	5,523	6,063	6,388	6,776	2.6%
			WE	5,433	5,335	5,333	5,305	5,382	5,963	6,268	6,544	2.9%
		Peak	WD	855	836	823	822	831	905	948	995	2.3%
			WE	830	820	824	820	834	921	968	1,007	3.1%
Facility Type	Freeway	Daily	WD	33,499	32,557	32,741	34,180	35,362	36,466	39,193	40,047	2.8%
			WE	28,496	27,562	27,996	29,238	30,485	31,960	34,093	34,419	3.0%
		Peak	WD	5,000	4,863	4,948	5,194	5,313	5,389	5,738	5,808	2.3%
			WE	3,994	3,887	3,971	4,146	4,338	4,543	4,813	4,847	3.0%
	Highway	Daily	WD	4,038	3,706	3,670	3,697	3,768	4,106	4,374	4,239	0.7%
			WE	3,522	3,292	3,284	3,314	3,364	3,654	3,883	3,700	0.7%
		Peak	WD	628	575	568	573	585	639	678	658	0.7%
			WE	554	519	520	524	534	577	613	581	0.7%
	Arterial	Daily	WD	13,672	13,454	13,819	13,697	13,568	14,308	14,907	14,635	1.0%
			WE	10,440	10,458	10,704	10,688	10,565	11,154	11,690	11,397	1.3%
		Peak	WD	2,146	2,109	2,165	2,155	2,134	2,221	2,300	2,240	0.6%
			WE	1,602	1,599	1,635	1,640	1,618	1,694	1,770	1,717	1.0%
Total		Daily	WD	15,233	15,003	15,100	15,522	15,647	16,566	17,732	17,977	2.6%
			WE	12,534	12,399	12,544	12,930	13,121	14,022	15,010	15,027	2.8%
		Peak	WD	2,324	2,287	2,317	2,392	2,394	2,501	2,655	2,666	2.1%
			WE	1,832	1,816	1,844	1,902	1,931	2,055	2,188	2,179	2.7%

WD=Weekday; WE=Weekend

The historical traffic patterns indicate weekend and weekday travel demand have grown somewhat in tandem. On average, the total daily and peak traffic on a weekend is lower than the weekday. However, weekend peak and daily volumes have been rising slightly faster than weekday peak and daily values (see annualized percent growth), indicating increasingly greater travel demand during weekends.

An analysis by area type and facility type reveals that weekend peak period volume relative to weekday peak period volume is highest for non-urban areas, where weekend peak period volume often surpasses that of the weekday peak period. Weekend volume relative to weekday volume is lowest for urban areas and especially so for arterials, where it captures only about three quarters of the weekday peak and daily volumes. This stands in contrast with the TTI_{95} analyses where the bulk of arterial roads experienced higher congestion during weekend peak period as compared to other facility types.

It is important to acknowledge that these continuous traffic monitoring sites may not be a representative sample and may not be located in the areas with the most acute weekend congestion.

3.3 Travel Time Performance Measures

As demonstrated in earlier sections, the congestion on weekends is most prevalent during peak period (Noon to 2 p.m.). Thus, the rest of the analysis focuses on developing performance measures for peak period and comparing them between weekday and weekend conditions.

The performance measure selected for comparing the congestion on weekdays and weekends is the 95th percentile travel index (TTI_{95}) also known as "Travel Time Reliability: Planning Time Index" (as included in The FDOT Source Book).

3.3.1 Impact of Definition of Free-Flow

TTI_{95} is defined as the ratio of the 95th percent travel time to the free flow travel time. This measure represents the additional time that a traveler should budget to ensure on-time arrival 95 percent of the time.

$$TTI_{95} = \frac{Travel\ Time_{95th\ percentile}}{Travel\ Time_{free\ flow}}$$

Currently, in The FDOT Source Book, free-flow travel time is set as the posted speed limit plus 5 mph. This definition of free-flow travel time works well when applied to freeways. However, it is unrealistic to expect that traffic would travel at 5 mph over the speed limit for signalized highway and arterial facilities. Even if, at times, spot speeds on these facilities were to reach that threshold, the ultimate travel time after accounting for stops at signs and traffic lights makes this definition for signalized highway and arterial facilities impractical.

Some of the contemporary nationwide mobility studies were researched to identify how the free-flow conditions are defined. In summary, some of the national practices define free-flow speed as:

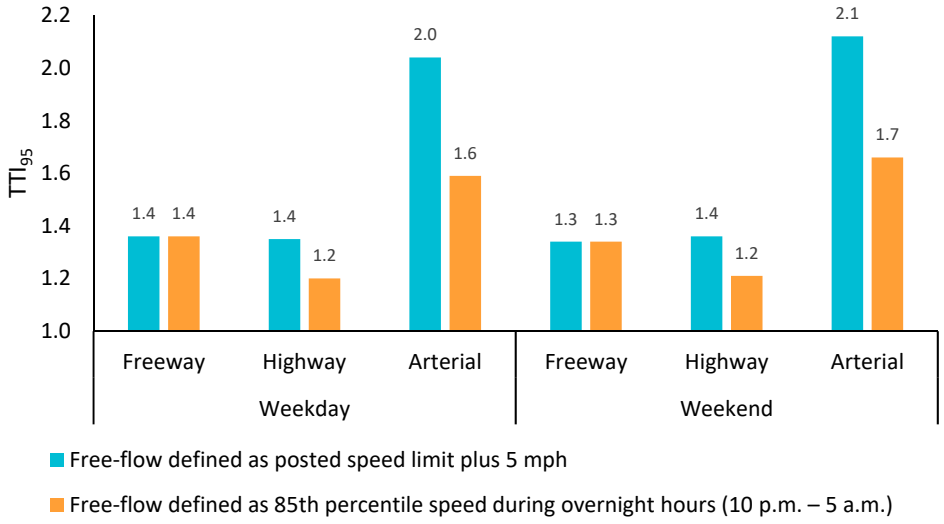
- FHWA Urban Congestion Report – 85th percentile speed during weekday off peak (9 a.m. – 4 p.m. and 7 p.m. – 10 p.m.) and weekend (6 a.m. – 10 p.m.)
- Texas Transportation Institute Urban Mobility Report – 85th percentile speed during overnight hours (10 p.m. – 5 a.m.)
- INRIX Global Traffic Scorecard – 85th percentile speed during overnight hours (10 p.m. – 5 a.m.)

In order to quantify the impact of free-flow on TTI_{95}, the following two definitions of free-flow speed were used and the results are compared.

- posted speed limit plus 5 mph
- 85th percentile speed during overnight hours (10 p.m. – 5 a.m.)

Figure 5 summarizes the impact of the different definitions of free-flow for weekday and weekend, broken down by facility type. The results indicate that definition of free-flow has minimal impact on freeways and has the biggest impact on arterials. The results using the definition of "85th percentile speed during overnight hours (10 p.m. – 5 a.m.)" is realistic, because they are based on the actual observed speeds during actual free-flow conditions, rather than on the posted speed limits.

Figure 5 Impact of Definition of Free-Flow on Peak Period TTI_{95}

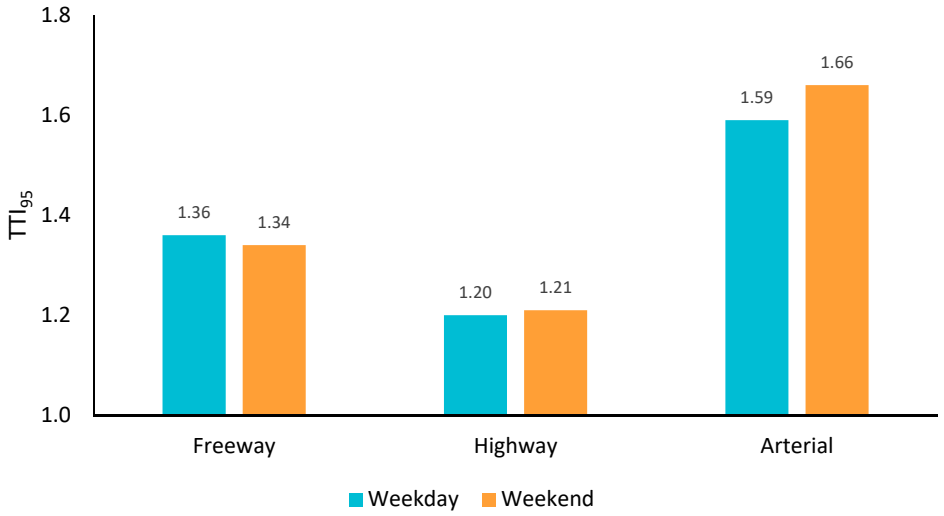


For the analysis in the remaining sections, free-flow definition of "85th percentile speed during overnight hours (10 p.m. – 5 a.m.)" is used.

3.3.2 Statewide Summary

Figure 6 summarizes the statewide aggregated results for peak period TTI_{95} for weekday and weekend, broken down by facility type, calculated using VMT-weighted averages. On freeways, most of the state roads experience lower weekend TTI_{95} values compared to weekdays. The trend is opposite for highways, and especially so for arterials.

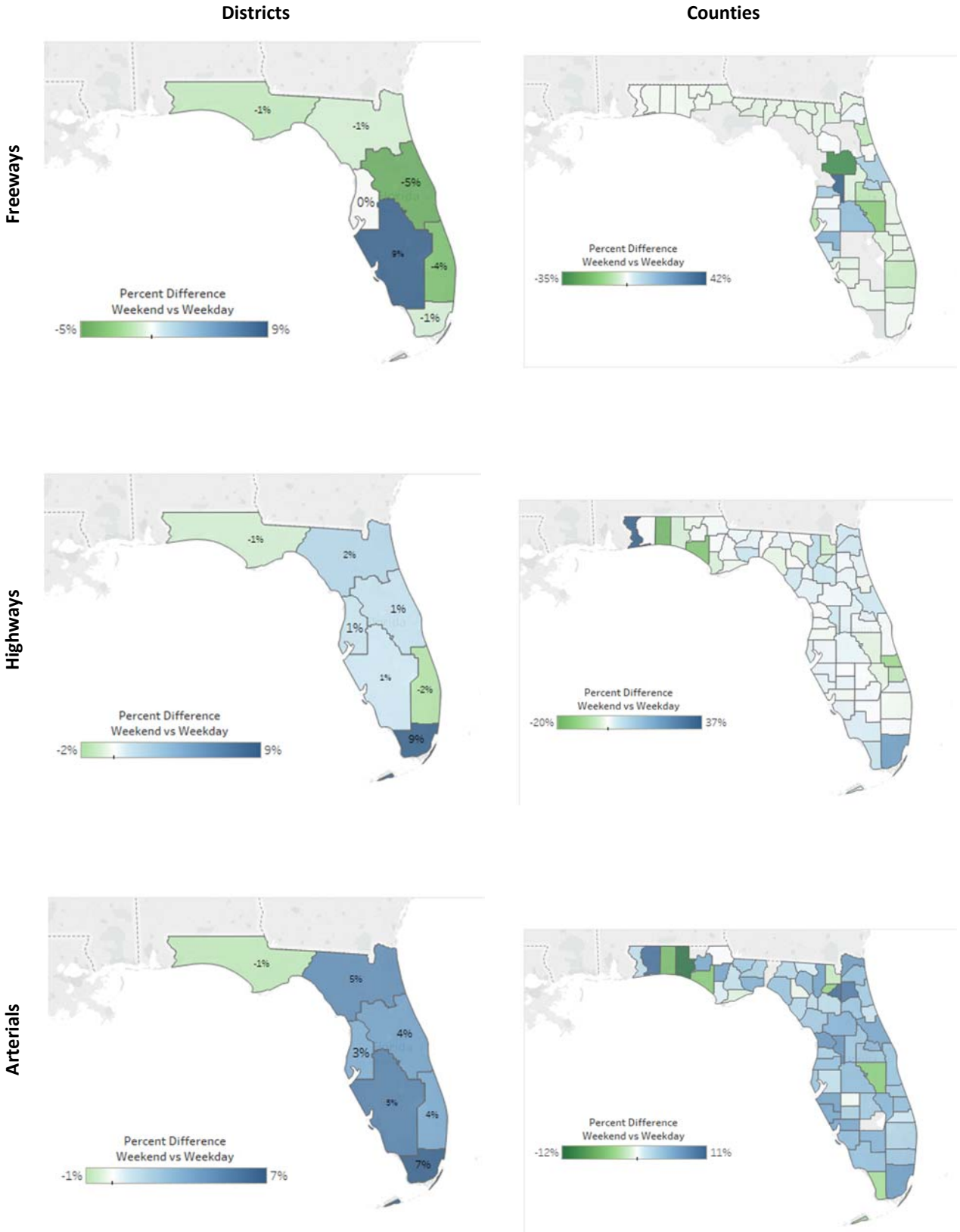
Figure 6 Statewide Results for Peak Period TTI_{95}



3.3.3 Results by Facility Type

Figure 7 displays the difference in peak period TTI_{95} for weekday and weekend conditions, broken down by facility type (freeways, highways and arterials), district and county. On freeways, most of the counties and districts experience lower weekend TTI_{95} values compared to weekdays. On the other hand, the trend is opposite for highways, and especially prominent for arterials. These trends follow statewide trends summarized in the previous section. It is interesting that the north-west corner of the state exhibits higher weekend TTI_{95} values for highways and arterials compared to the rest of the state – with Escambia County's difference of 37% between weekend and weekday for highways.

Figure 7 Peak Period TTI_{95} Results – by District, County and Facility Type



Note: Darker blue color indicates that congestion during weekend peak period is higher than the weekday peak period.

3.3.4 Results by Context Classification

The TTI_{95} results were also broken down by FDOT's Context Classifications (see **Figure 8**)[2]. **Figure 9** shows that, overall, the greater the density of the context class, the greater the TTI_{95} values for both weekdays and weekends. However, while all classes except for C1 (Natural) experienced higher TTI_{95} values during the weekends, the ones that experienced the highest difference are C4 (Urban General, 6%), followed by C5 (Urban Center, 4%) and C3C (Suburban Commercial, 4%).

Figure 8 FDOT's Context Classifications

Figure 9 Peak Period TTI_{95} Results – by Context Classifications

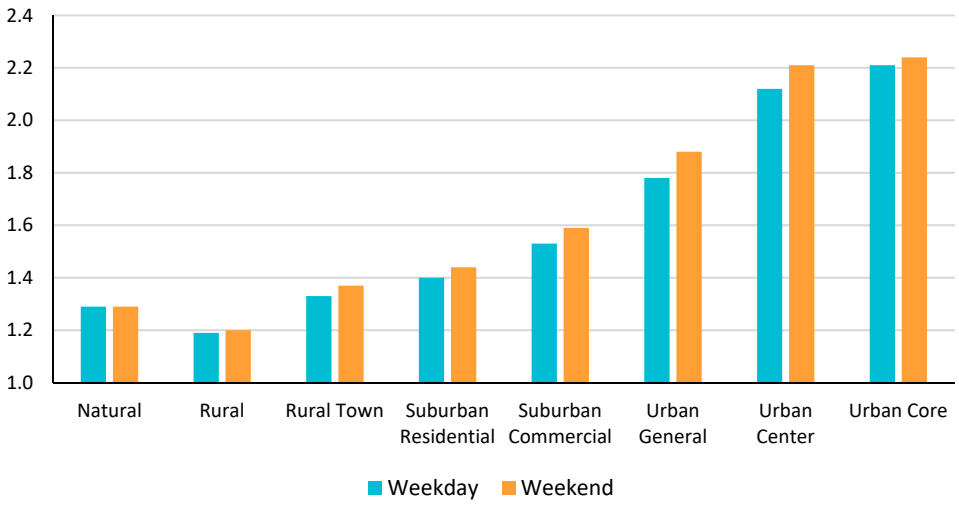
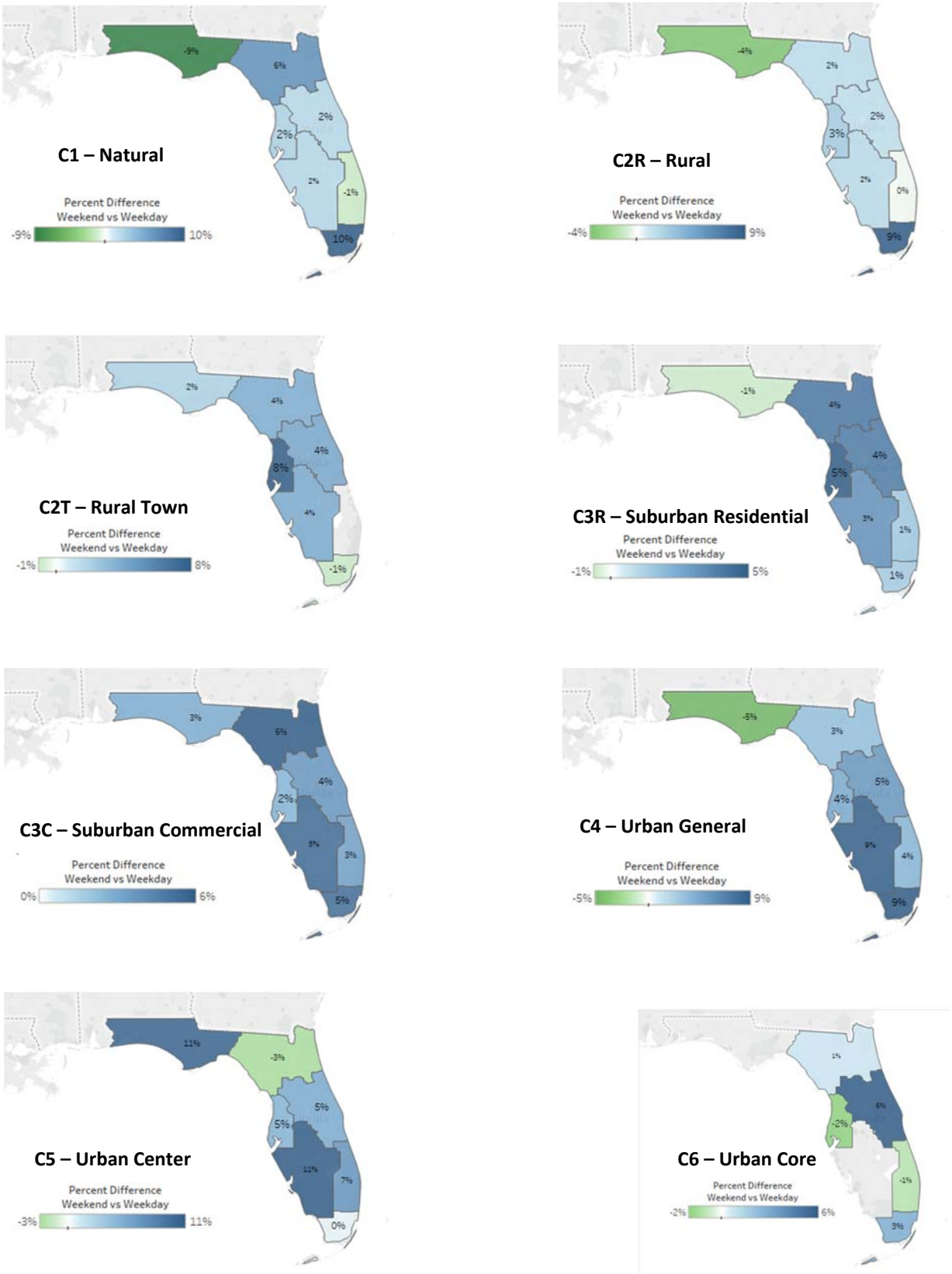


Figure 10 shows the results broken by district for each context classification. Most of the context classifications witness greater congestion during the weekend peak period compared to weekday peak period, as measured by TTI_{95}. It is worth noting that District 3 has lower congestion in the weekends compared to the weekdays for most context classifications – with one notable exception being C5 (urban center) whose weekend TTI_{95} is 11% greater than the weekday one. Also, the C3C (Suburban Commercial) context classification is the only one where all seven districts experienced more congestion on weekend peak period than weekday peak period.

[2] For more information about FDOT's Context Classification see https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/completestreets/files/fdot-context-classification.pdf?sfvrsn=12be90da_2

Figure 10 Peak Period TTI_{95} Results – by District and Context Classifications



Note: Darker blue color indicates that congestion during weekend peak period is higher than the weekday peak period.

4.0 Implications for Federal System Performance Measures

The MAP-21/FAST Act System Performance (PM3) travel time reliability measures were the catalyst that encouraged FDOT to further investigate weekend congestion and this has been a valuable endeavor. After conducting this analysis, however, we recognize that there are certain limitations with respect to the outlined time periods. While the federal measures are appropriate for weekdays, identifying several periods of analysis (morning peak, mid-day peak, and evening peak periods), weekends are lumped into one single 14-hour period from 6 a.m. to 8 p.m. This study shows that there are significant differences in congestion levels throughout the day during the weekend. The PM3 measures may be able to gain more nuance by further segmenting the period of analysis during the weekends.

The second aspect to point out is that the PM3 reliability measures are an aggregation of the "level of travel time reliability" (LOTTR) for each segment, which in turn is calculated using the 80th percentile travel time divided by the 50th percentile travel time for each segment. In the case of heavily congested areas, the 50th percentile travel time will be much higher than the free flow travel time. For those segments, the resulting LOTTR will be relatively low even though they experience high congestions, simply because there is a smaller difference between the 80th and 50th percentile travel times than they would otherwise experience if they were not consistently congested. The PM3 measures may be able to better identify congested segments if they use a denominator equivalent to the free-flow travel time.

5.0 Recommendations

This analysis shows that weekend congestion is real and present, and especially true during peak periods. These findings reveal the need to acknowledge the importance of weekend congestion, initially through incorporating weekend performance measures as part of agencies' performance monitoring processes and later by planning for and engaging in decision making informed by weekend congestion patterns. Based on this analysis, the project team recommends that weekend performance measures be incorporated in The FDOT Source Book starting in 2020.

A key finding is that the way that its Mobility Measures Program has been calculating free flow works well for freeways, but not so well for highways and arterials. Free-flow travel time should be calculated based on the 85th percentile speed during overnight hours. This represents a more realistic free flow scenario for non-freeways and works just as effectively for freeways.

Weekend congestion patterns on arterial facilities merit further study. Arterials carry lower traffic on weekends compared to weekdays, but experience higher congestion on weekends compared to weekdays. This may suggest that either the permanent count stations are not a representative sample to accurately capture weekend travel demand, and/or that high TTI_{95} during the weekend peak period is caused by factors other than travel demand.

In addition to reporting weekend congestion, there may be opportunities to manage it more effectively. There are several actions that transportation agencies can take to improve congestion during weekends, including:

- **Signal timing** – In the case of Florida, volumes during the weekend peak period are lower than during the weekday peak period for all area types and facility types. However, weekend peak period TTI95 is

higher than weekday peak period. This could suggest that higher weekend congestion may be a reflection of poor signal timing.

- **Traffic Management Centers** – Following the traditional assumption that congestion predominantly occurs during weekdays, traffic management centers typically have lower monitoring activity during the weekends. This study shows that there may be a need to have stronger monitoring during the weekends to better manage this type of congestion, including having appropriate incident management capabilities.

- **Other localized solutions** – Peak weekend congestion is generated by different types of travel demand when compared to peak weekday congestion (e.g. weekend shopping vs. commuting trips). Conducting studies to better understand what drives weekend congestion at a local level may help transportation agencies identify local, context-sensitive solutions to weekend congestion.