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Data-Driven Decisions in Transportation – An Assessment of Louisiana's Freight Mobility Goals

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ABSTRACT

This study developed a methodology to meet the goals of increasing statewide commercial vehicle operations (CVO) to facilitate economic growth on major freight routes. The methodology used CVO in the state of Louisiana as a test bed. The performance measures used in the methodology were the Truck Travel Time Reliability (TTTR) Index and vehicle user delay cost for periods between 2016-2020, which were sourced from the National Performance Management Research Data Set (NPMRDS). The results show Louisiana's interstate highway remained reliable with TTTR Index scores of less than 1.50, but some Traffic Messaging Channels (TMC) segments experienced maximum TTTR scores greater than 1.50, which were altogether 15.47% of the interstate highway system, as of 2020. The 15.47% of the interstate highway contributed, on average, 72.34 % of the annual user delay cost between 2016 and 2019 and 62.49% in 2020, which are extremely high considering the length of the interstate system. This methodology demonstrates how data can be used to set transportation mobility priorities and how data can be used to identify areas with the greatest need for improvement in a transportation system.

Keywords: Freight; Operations; Performance Measures; TTTR Index; Data-Driven; Commercial Vehicle Operation

1. BACKGROUND

The Moving Ahead for Progress in the 21st Century Act (MAP-21) established the National Freight Movement and Economic Vitality goal to improve the national freight network, access to markets, and support regional economic development in the United States. The Fixing America's Surface Transportation (FAST) act continued these and established freight-specific funding programs and requirements [1, 2]. To meet these requirements, the United States Department of Transportation (USDOT) developed a national policy to improve the condition and performance of the freight network to ensure the United States competes globally [3]. These requirements have necessitated the implementation of performance-driven, outcome-based programs by state Departments of Transportation (DOTs) to improve decision-making and efficient utilization of federal funds [4].

To align with the need to implement performance-driven, and outcome-based commercial vehicle operations, the Department of Transportation and Development (DOTD) has set Louisiana's freight operations goal to increase freight mobility, facilitate freight and economic growth, and reduce commercial vehicle crash rates [5]. Also, to assess how this broad goal is being met, specific objectives and corresponding performance measures have been developed by Louisiana [6]. Additionally, in accordance with 23 CFR 490 - National Performance Management Measures, the Federal Highway Administration (FHWA) established the Truck Travel Time Reliability (TTTR) performance measure that states DOTs need to assess the performance of freight movement on the interstate highway system [7]

1.1 Objectives

Using the CVO in Louisiana as a test bed, this paper develops a methodology to assess how states have met their freight mobility goal to increase freight mobility and facilitate economic growth, using the following performance measures:

- TTTR Index
- Commercial Vehicles User Delay Costs.

This assessment helps to identify a state's freight-related transportation improvement needs and ensures targets and measures are based on data and objective information.

1.2 Scope of Study

Figure 1 [5] shows truck freight movements in Louisiana heavily rely on the interstate highway system, with I-10, I-12, and I-20 providing much of the east-west movement, while I-49, I-55, and I-59 facilitate north-south movements. Thus, the freight-significant highway considered for evaluation was Louisiana's interstate highway system.

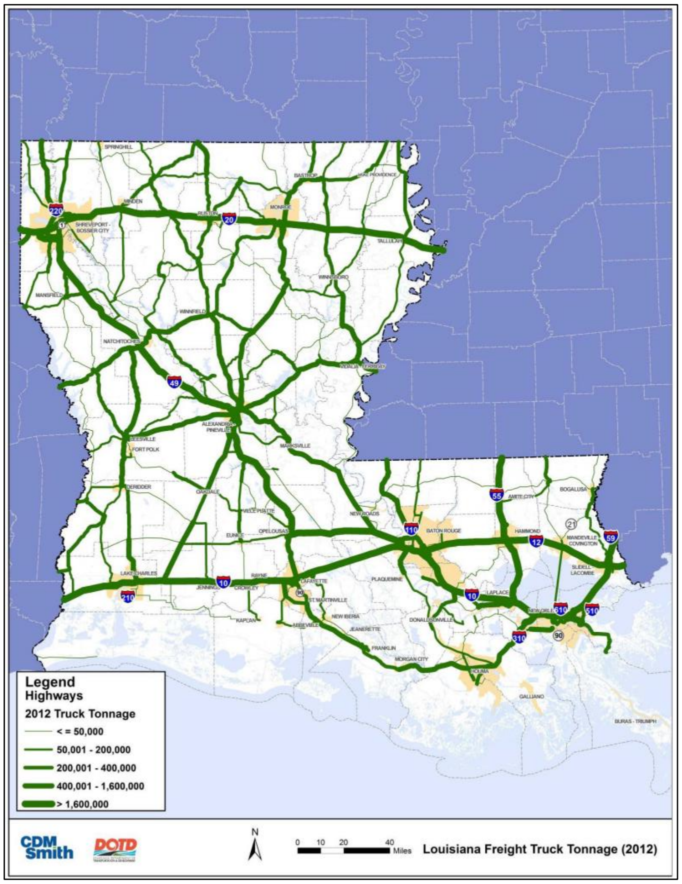


Figure 1. Freight significant highways in Louisiana [5]

2. METHODOLOGY

2.1 Performance Measures

Truck Travel Time Reliability (TTTR) Index

TTTR Index is the Freight Movement Reliability performance measure on a statewide interstate highway system defined by the PM3 federal rule (23 CFR Part 490 Subpart F Measure) [8]. The TTTR is the ratio of the longer travel time (95th Percentile) to a normal travel time (50th percentile) computed in 15-minute travel intervals, as expressed in **Equation 1**, computed for each interstate segment statewide and rounded to the nearest hundredth for each applicable period for the entire year.

$$TTTR_i = \frac{95th\ Percentile\ Travel\ Time_i}{50th\ Percentile\ Travel\ Time_i} \quad \ldots\ldots \quad (1)$$

Where i is the time-period:

Monday – Friday	AM Peak	6:00am – 10:00am
	Mid-Day	10:00am – 4:00pm
	PM Peak	4:00pm – 8:00pm
Weekends		6:00am – 8:00pm
Overnight (all days)		8:00pm – 6:00am

The maximum TTTR of all five time periods for each segment to the nearest hundredth is used to create the TTTR Index for the entire interstate system. Mathematically, the TTTR Index is the sum of the maximum TTTR for each reporting segment, divided by the total interstate highway system miles, as expressed in **Equation 2**.

$$TTTR\ Index = \frac{\sum_{i=1}^{T}(Sl_i \times maxTTTR_i)}{\sum_{i=1}^{T}(Sl_i)} \quad \ldots\ldots \quad (2)$$

Where:

i = an interstate highway reporting segment
$maxTTTR_i$ = the maximum TTTR of all five time periods for segment i
Sl_i = length of segment i
T = total number of Interstate segments

Interstate highways segment with a TTTR of less than 1.50 are considered reliable; conversely, those with TTTR greater than 1.50 are considered unreliable.

The following interpretations are generally given to the TTTR:

TTTR	Interpretation
Less than (<) 1.25	Very Good
1.25 – 1.40	Good
1.40 – 1.50	Barely Good
1.50 – 1.60	Barely Bad
1.60 – 1.75	Bad
Greater than (>) 1.75	Very Bad

The target for the TTTR Index on Louisiana highway systems is set at 1.50.

Commercial Vehicles User Delay Cost

The User Delay Cost Analysis tool in the NPMRDS Analytics was used to estimate the delay cost on the freight-significant highways from 2016 to 2021. The Texas Transportation Institute 2017 estimates for vehicle operating costs of $100.49 per hour for commercial vehicles and $17.91 per hour for passenger vehicles were applied [9]. A 20% commercial vehicle population estimate for Louisiana based on the 2010 distribution of annual vehicle distance traveled [10] and information provided in the study by DOTD [11] was used. Only single-unit and combination trucks were considered commercial vehicles for the volume mix estimated.

With free-flow speed defined as the mean speed in mph (capped at 65 mph) calculated based on the 85th-percentile of the observed speeds on a segment for all time periods, the delay was calculated for all segments whose raw speeds fell 15 mph or worse than the free-flow speed of a segment. This measure showed delay costs for any time the speeds were 15 mph worse than free-flow speeds on a TMC segment [9].

2.2 Data Sources and Scope of Collection

The TTTR Index and user delay costs data were sourced from the NPMRDS and calculated on the Regional Integrated Transportation Information System (RITIS) platform and the

User Delay Cost Analysis widget for periods between 2016 and 2021 [9].

3. DATA ANALYSIS AND DISCUSSION

3.1 Truck Travel Time Reliability Index

The box plots shown in **Figure 2** show the TTTR (95th/50th) values calculated for the five periods: AM Peak, Midday, PM Peak, Weekend, Overnight, and Maximum TTTR observed in 2016 across the five-time periods by all TMC segments in Louisiana, which was similar to the other years. Overall, TTTR values calculated for the five periods were skewed towards TTTR = 1.00, with the central tendencies across the periods below the 1.50 target, which are considered good.

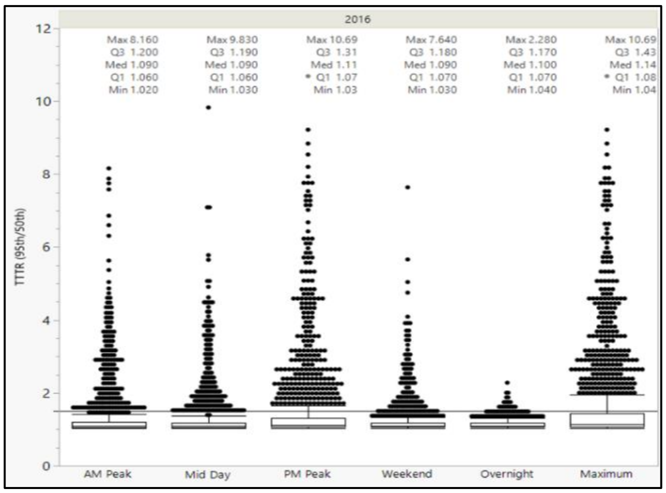


Figure 2. TTTR – Louisiana interstate highway system, 2016

Though the five summary numbers from the distributions shown on the box plots in **Figure 2** suggested that about 25% of the observed yearly maximum TTTR values were outliers, the interstate highway system in Louisiana remained reliable over the study period with a monthly TTTR Index of less than 1.50 across the years except for August 2016, where a TTTR Index greater than 1.50 was experienced.

For the TTTR Index, aggregated yearly between 2016 and 2020, the interstate system remained reliable, with the best performance experienced in 2020, with a TTTR Index of 1.26, and the worst performance of 1.35 experienced in 2018 and 2019, as shown in **Table 1**, all of which are considered good performances for the interstate highway system for freight operations per the target set by Louisiana.

Performance of TMC Segments on the Highway System

In all, 412 TMC segments recorded a bad TTTR score during the period out of the 1504 TMC segments that made up the entire (100%) interstate highway system as of 2020. These 412 TMC segments, which summed up to 291.04 miles (15.47%) of the total 1881.65 TMC mileage, are shown in **Figure 3**. From the plot, locations with high clusters of these bad-performing TMC segments were mainly within New Orleans, Baton Rouge, Shreveport, and Lake Charles.

Table 1. TTTR Index – Louisiana interstate highway systems

Monthly TTTR Index					
Month\Year	**2016**	**2017**	**2018**	**2019**	**2020**
January	1.31	1.31	1.34	1.42	1.31
February	1.37	1.38	1.35	1.41	1.36
March	1.45	1.36	1.42	1.47	1.27
April	1.38	1.35	1.42	1.37	1.11
May	1.37	1.41	1.38	1.4	1.14
June	1.36	1.38	1.42	1.4	1.23
July	1.42	1.34	1.37	1.42	1.22
August	1.53	1.36	1.37	1.4	1.26
September	1.39	1.39	1.42	1.33	1.4
October	1.38	1.34	1.42	1.39	1.4
November	1.44	1.4	1.42	1.4	1.33
December	1.36	1.33	1.38	1.39	1.3
Yearly TTTR Index					
Year	**2016**	**2017**	**2018**	**2019**	**2020**
TTTR Index	1.33	1.31	1.35	1.35	1.26

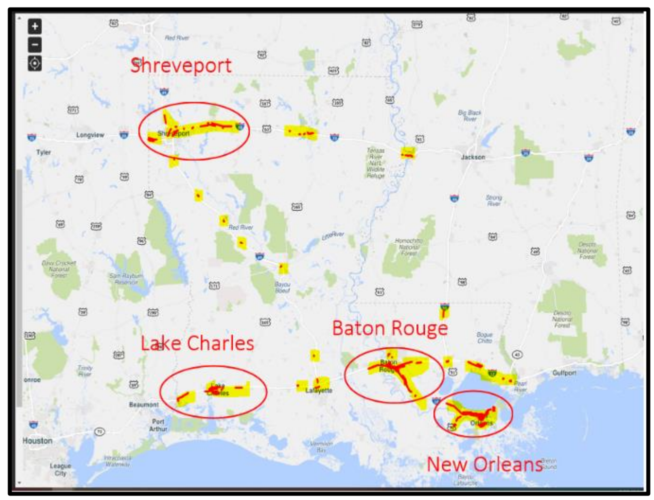


Figure 3. Bad performing TMC segments in Louisiana (TTTR>1.50) from 2016-2020

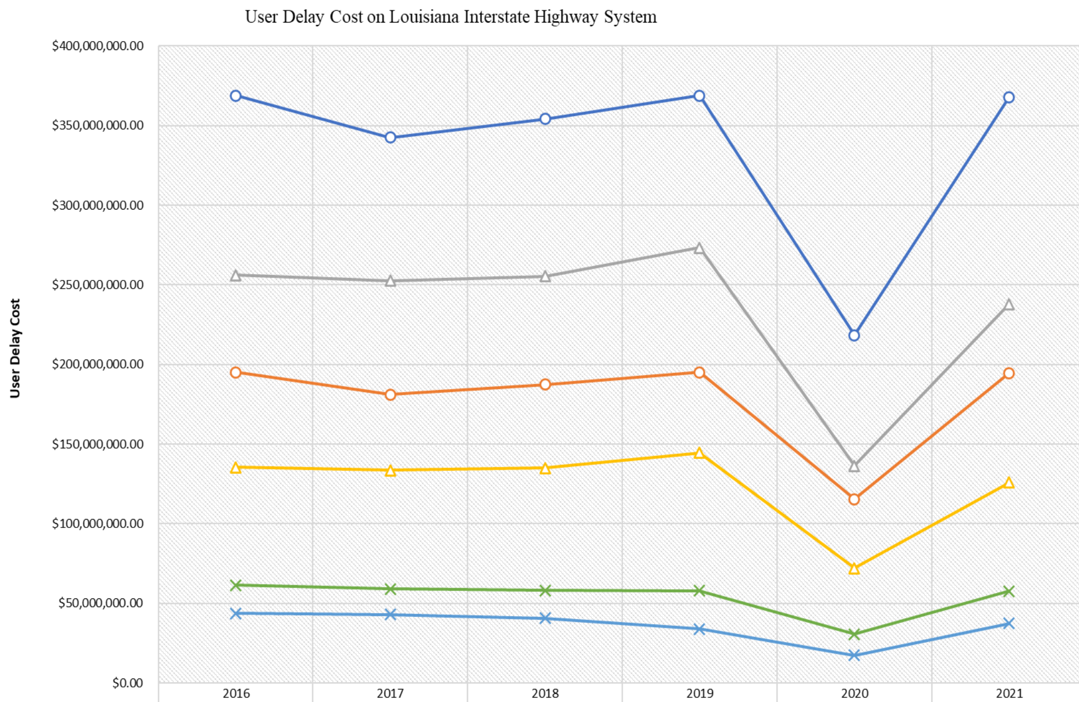
An analysis of the user delay costs on the entire interstate highway system, on the 412 bad-performing TMC segments, and at two urban locations with a high cluster of the bad-performing TMC segments are presented in the subsequent section.

3.2 Truck User Delay Cost Analysis

The user delay costs on Louisiana's interstate highway system by commercial vehicles and by all vehicles on the entire (100%) interstate highway system and the 412 bad-performing TMC segments are presented, in **Figure 4**, in addition to the user delay cost experienced by commercial vehicles (only) on the bad performing TMC segments in New Orleans and Baton Rouge between 2016 and 2021.

From observation, the annual user delay costs by commercial vehicles and the user delay cost by all vehicles remained relatively stable between 2016 and 2019, dipped in 2020, and returned to the previous trend in 2021. Comparatively, the commercial vehicle user delays on 6.72% of the total TMC mileage of the interstate highway (in New Orleans and Baton Rouge with a maximum TTTR > 1.50) annually contributed to, on average:

- 38.11% of the user delay costs on the 412 TMC segments (with a maximum TTTR > 1.50).
- 72.07% of the annual commercial vehicle user delay cost on the 412 TMC segments (with a maximum TTTR > 1.50).
- 50.04% of the corresponding annual commercial vehicle user delay cost on the statewide interstate highway system.
- 26.46% of the total annual user delay cost on the statewide interstate highway system.



	2016	2017	2018	2019	2020	2021
User Delay Cost (All Veh. - Statewide)	$368,939,819.52	$342,662,843.93	$354,196,222.00	$368,807,444.74	$218,371,538.97	$367,845,316.50
User Delay Cost (Com. Veh. - Statewide)	$195,089,257.33	$181,194,428.47	$187,293,087.50	$195,019,259.75	$115,471,247.90	$194,510,502.29
User Delay Cost (All Veh. - 412 TMC Segments)	$256,134,429.42	$252,519,453.42	$255,371,836.16	$273,450,412.70	$136,456,417.53	$237,977,086.30
User Delay Cost (Com. Veh. - 412 TMC Segments)	$135,439,638.04	$133,528,098.69	$135,036,391.37	$144,596,042.79	$72,155,890.33	$125,838,336.15
User Delay Cost (Com. Veh. - 92 TMC Segments, BR)	$43,603,930.20	$42,925,113.57	$40,556,881.60	$33,943,322.09	$17,372,419.63	$37,426,355.17
User Delay Cost (Com. Veh. - 146 TMC Segments, NO)	$61,278,758.97	$59,023,031.18	$58,150,076.41	$57,807,463.30	$30,566,841.76	$57,743,046.69

BR - Baton Rouge, NO - New Orleans

Figure 4. User delay cost on Louisiana interstate highway system (2016-2021)

4. CONCLUSIONS

This paper develops a methodology to assess how states have met their freight mobility goal to increase freight mobility and economic growth. It uses the TTTR Index and commercial vehicle user delay cost as performance measures and Louisiana's commercial vehicle operations as a test bed.

Overall, Louisiana's interstate highway remained reliable over the study period from 2016 to 2020, with TTTR Index scores of less than the 1.50 threshold set by Louisiana to measure reliability. There exist, however, TMC segments in Louisiana that experienced maximum TTTR scores of greater than 1.50 on the interstate highway system. These TMC segments, which contribute to unreliable truck travel times, were 15.47% of the total statewide TMC mileage of the statewide interstate highway system and were mainly clustered in New Orleans, Baton Rouge, Shreveport, and Lake Charles.

In general, the annual user delay costs by commercial vehicles and the user delay cost by all vehicles remained relatively stable between 2016 and 2019 but dipped in 2020. The trend of the user delay cost bounced back in 2021.

The following were deduced from the comparative ratios of the user delay costs between 2016 and 2021:

- Commercial vehicle user delay costs are, on average, 52.88% of the user delay cost experienced by all vehicles on the same interstate highway system, ceteris paribus.
- The 15.47% of the total statewide TMC mileage of the interstate highway (with a maximum TTTR>1.50) contributed, on average, 72.34 % of the annual user delay cost between 2016 and 2019. The proportion dropped to 62.49 percent in 2020 and only increased to 64.69% in 2021, short of

the pre-COVID-19 averages. These proportions are extremely high, considering the full length of the interstate highway.

Recommendation for Future Studies

To make significant improvements to freight mobility and increase economic growth, DOTD must address the travel reliability issues on bad-performing TMC segments, especially the 6.72% of the total statewide TMC mileage located in New Orleans and Baton Rouge. Future research can investigate the features that contribute to these higher TTTR scores and propose measures to improve reliability.

Significance of Study

This study developed a methodology to increase statewide commercial vehicle operations (CVO) to facilitate economic growth on major freight routes and Louisiana's commercial vehicle operations as a test bed. It is an example of how data can be used to set transportation mobility priorities and also demonstrates how data can be used to identify areas with the greatest need for improvement in a transportation system. Transportation agencies using data and performance measures can use approaches such as those demonstrated by this paper to identify root causes of transportation problems and propose solutions based on data.

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AUTHOR CONTRIBUTIONS

The authors confirm the paper's contribution: paper conception and design; data collection: K. A. Abedi; analysis and interpretation of results: K. A. Abedi, R, Thapa, J. Codjoe & V.K.A. Gopu; draft manuscript preparation: K. A. Abedi, R. Thapa, J. Codjoe & V.K.A. Gopu. All authors reviewed the results and approved the final version of the manuscript.

5. REFERENCES

[1] US Law, Case Law, Codes, Statutes & Regulations. 2013 US Code. Title 23 – Highways. Chapter 1 - FEDERAL-AID HIGHWAYS (§§ 101 - 190). Section 167 - National freight policy. https://law.justia.com/codes/us/2013/title-23/chapter-1/section-167/. Accessed 1 Apr. 2022.

[2] Federal Highway Administration (FHWA). Transportation Performance Management. Truck Freight Bottleneck Reporting Guidebook. July 2018. FHWA-HOP-18-070. https://www.fhwa.dot.gov/tpm/guidance/hop18070.pdf. Accessed: March 29, 2022

[3] U.S. Department of Transportation. National Freight Strategic Plan. Last updated: Friday, September 4, 2020. https://www.transportation.gov/sites/dot.gov/files/2020-09/NFSP_fullplan_508_0.pdf. Accessed: March 09, 2022.

[4] M. Grant, J. D'Ignazio, A. B. and A. McKeeman, Performance-Based Planning and Programming Guidebook, ICF International, Inc. United States Department of Transportation, September 2013. https://www.transit.dot.gov/sites/fta.dot.gov/files/Performance_Based_Planning_and_Programming_Guidebook.pdf. Accessed: March 31, 2022.

[5] CDM Smith Inc. Louisiana Department of Transportation and Development. "2015 Statewide Transportation Plan." Statewide Transportation Plan, November 18, 2016, http://www.dotd.la.gov/Inside_LaDOTD/Divisions/Multimodal/Transportation_Plan/Pages/default.aspx. Accessed: March 05, 2022.

[6] Thapa R., J. Codjoe and K. Abedi. Develop and Evaluate Performance Measures for Intelligent Transportation Systems (ITS) in Louisiana. SIO Number: DOTLT1000379. Louisiana Transportation Research Center, Louisiana State University, 2022.

[7] Federal Register. National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program. https://www.federalregister.gov/documents/2017/01/18/2017-00681/national-performance-management-measures-assessing-performance-of-the-national-highway-system. Accessed: March 05, 2022.

[8] Code of Federal Regulations. Subpart F - National Performance Management Measures to Assess Freight Movement on the Interstate System. https://www.ecfr.gov/current/title-23/part-490/subpart-F. Accessed: March 05, 2022.

[9] Regional Integrated Transportation Information System. NPMRDS Frequently Answered Questions. https://npmrds.ritis.org/analytics/help/. Accessed: March 05, 2022.

[10] Federal Highway Administration, "Distribution of Annual Vehicle Distance Traveled – 2010". https://www.fhwa.dot.gov/policyinformation/statistics/2010/pdf/vm4.pdf. Accessed: March 02, 2022.

[11] Codjoe, J., R. Thapa, and A. Osafo. Louisiana Transportation Research Center. 'Evaluation of DOTD's Existing Queue Estimation Procedures,' Published Date: 2021-01-01, Report Number: FHWA/LA.17/642, https://rosap.ntl.bts.gov/view/dot/58390. Accessed: February 02, 2022.