Louisiana Transportation Research Center

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Evaluating Cell Phone Data for AADT Estimation

by

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16. Abstract

AADT estimation facilitates the process of determining and prioritizing funds for both road safety and improvement projects. Traffic counts over non-state roadways are normally the responsibility of local governments and the Metropolitan Planning Organizations of Louisiana's major cities. Other non-state roadways in rural and small urban areas do not have such systemic traffic counts or estimation programs so these areas tend to lack timely traffic volumes across non-state and local roads. Streetlytics is being considered as a potential supplement for systemically providing AADTs on all state and non-state roadways within Louisiana. In this study, a bivariate correlation analysis and quantitative analysis (percentage difference) were used to evaluate the comparability of Streetlytics' volume counts with traditional DOTD counts. Simple linear regression was then used to develop predictive models that accounted for the differences between the two datasets. The data was analyzed on three levels to compare Traditional count data to Streetlytics counts. Level 1 comprised all data, level 2 comprised Routine count data versus Permanent count data, and level 3 comprised Observed locations versus Unobserved locations. Overall, the results confirmed strong positive correlation between Streetlytics data and Traditional count data. Analysis of all the data in Level 1 produced a percentage difference value of 44.50% with Traditional count data reporting higher values than Streetlytics count data. Routine counts and Permanent counts analyzed at level 2 had percentage differences of 45.01% and 43.00% respectively. At level 3, Unobserved locations from Routine and Permanent count data had percentage differences of 53.90% and 43.00% respectively while a percentage difference of 23.60% was obtained for Observed locations (Routine count data). Furthermore, the percentage difference between the two datasets for Traditional count data under 300 vpd was 110.38%. For Traditional count data over 300 vpd however, the percentage difference between the two datasets was 37.08%. Approximately 10% of the data falls under 300 vpd and 3% falls below 50 vpd. The study recommends adoption of the On-Premises dataset of Streetlytics to supplement the efforts of DOTD's Traffic Monitoring Unit. The study further recommends subscribing to the Monthly data which takes into account seasonal variations and provides typical volumes for a day in a month of a given year and negotiating with the vendor to set minimum AADT value to 50 vpd from the current value of 300 vpd.

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AADT estimation facilitates the process of determining and prioritizing funds for both road safety and improvement projects. Traffic counts over non-state roadways are normally the responsibility of local governments and the Metropolitan Planning Organizations of Louisiana's major cities. Other non-state roadways in rural and small urban areas do not have such systemic traffic counts or estimation programs so these areas tend to lack timely traffic volumes across non-state and local roads. Streetlytics is being considered as a potential supplement for systemically providing AADTs on all state and non-state roadways within Louisiana. In this study, a bivariate correlation analysis and quantitative analysis (percentage difference) were used to evaluate the comparability of Streetlytics' volume counts with traditional DOTD counts. Simple linear regression was then used to develop predictive models that accounted for the differences between the two datasets. The data was analyzed on three levels to compare Traditional count data to Streetlytics counts. Level 1 comprised all data, Level 2 comprised routine count data versus Permanent count data, and Level 3 comprised Observed locations versus Unobserved locations. Overall, the results confirmed strong positive correlation between Streetlytics data and Traditional count data. Analysis of all the data in Level 1 produced a percentage difference value of 44.50% with Traditional count data reporting higher values than Streetlytics count data. Routine counts and Permanent counts analyzed at level 2 had percentage differences of 45.01% and 43.00% respectively. At Level 3, Unobserved locations from Routine and Permanent count data had percentage differences of 53.90% and 43.00%, respectively, while a percentage difference of 23.60% was obtained for Observed locations (Routine count data). Furthermore, the percentage difference between the two datasets for Traditional count data under 300 vpd was 110.38%. For Traditional count data over 300 vpd however, the percentage difference between the two datasets was 37.08%. Approximately 10% of the data falls under 300 vpd and 3% falls below 50 vpd. The study recommends adoption of the on-premises dataset of Streetlytics to supplement the efforts of DOTD's Traffic Monitoring Unit. The study further recommends subscribing to the Monthly data which takes into account seasonal variations and provides typical volumes for a day in a month of a given year and negotiating with the vendor to set minimum AADT value to 50 vpd from the current value of 300 vpd.

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IMPLEMENTATION STATEMENT

The results obtained from this study can potentially lead to the adoption of Streetlytics (offered as On-Premises Dataset and/or Online User Interface) by the Louisiana Department of Transportation and Development (DOTD) to provide readily available traffic data to all state and local agencies. A statewide subscription license for the On-Premises Dataset will provide all agencies instant access to traffic volumes and AADT for every street within the state. Data can be downloaded and used in geographic information services (GIS) platforms such as ArcGIS. Demographics, segmentation, and speed data can be purchased as add-ons. A subscription license for the Online User Interface will provide traffic volumes, AADT, origin and destination patterns, demographics, and segmentation data but cannot be downloaded. Information from Streetlytics will be critical in roadway planning, roadway safety assessments, and roadway maintenance. Streetlytics also has the added potential of providing valuable information for businesses, consumers, and commuters in Louisiana. However, DOTD will have to review next steps in how to fully integrate this dataset into their existing data usage and reporting systems.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Annual Average Daily Traffic (AADT) represents the average traffic volume each day that a particular roadway segment accumulates over an entire year. For any state agency, AADT is vital for roadway planning, pavement maintenance, roadway design, traffic operations, air quality assessments, revenue planning from roadway user fees, and roadway safety assessments. AADT is also required to calibrate and validate travel demand models, estimate state-wide vehicle-miles traveled (VMT) in compliance with the 1990 Clean Air Act Amendment, and must also be reported annually by any state's Department of Transportation (DOT) to the Federal Highway Administration (FHWA).

Currently in the state of Louisiana, the Traffic Monitoring unit of the Louisiana Department of Transportation and Development (DOTD) estimates AADT for FHWA reporting, and generates the correction factors for AADT estimation from about 60 Permanent count stations scattered over the state, all in accordance with the FHWA Traffic Monitoring Guide *[1]*. The unit collects 48-hour short duration "Routine" counts on approximately 1,400 sites across a third of the state each year, resulting in approximately 4,200 sites statewide over a 3-year period. These sites are located "on-system routes" comprising mainly state owned roadways and some local roadways that either connect or greatly affect the traffic on the state roadways. Traffic counts over non-state roadways are normally the responsibility of local governments and the Metropolitan Planning Organizations (MPOs) of Louisiana's major cities such as Baton Rouge, New Orleans, Lafayette, Lake Charles, etc. Outside metropolitan areas, smaller cities and rural areas do not have the budgets for such systemic traffic counts or estimation programs resulting in a lack of timely traffic volumes across these non-state and local roads. The possession of limited data hinders roadway safety assessments and the development of cost-effective safety improvement projects in these areas.

With approximately 205,308 routes (unique roadways) within Louisiana, there is the need to find a practical, cost-effective, and progressive method of estimating AADTs across the entire state, as a way to supplement the current AADT estimation efforts. Streetlytics, a mapping tool developed using advanced transportation analytics, provides detailed traffic data across the United States, and has the potential to systemically estimate AADTs across all state and non-state roadways within Louisiana. The data Streetlytics provides is extracted from several sources including cell phones, mobile GPS, navigation systems, employment tax records, building permits, postal delivery volumes, and publicly available state-reported AADTs. Streetlytics promises to provide the following for every roadway: AADT (all year round); average daily traffic (ADT) volumes (for morning and evening peaks, off peak, and daily); predominant direction of traffic flow (morning and evening peaks); congestion patterns (for morning and evening peaks, off peak, and daily); driver demographics (age, income, household size, and gender); trip purpose (work, home, or other); and travel patterns (origin and destination nodes); among others.

The purpose of this research is to validate the AADT counts reported by Streetlytics by using the Baton Rouge Metropolitan Area (BRMA) as a test case. The study utilized a bivariate correlation analysis and a comparative analysis, using percentage difference, to evaluate how Streetlytics' AADT estimates (referred to as Streetlytics count data) compared to traditional AADT estimates (referred to as Traditional count data). The Traditional count data were split into Routine count data and Permanent count data, the former estimated using the 48-hour short duration counts and the latter comprising data collected from Permanent count stations. Simple linear regression was used to develop predictive models to account for any differences between the two sets of data. The objective of the study is to use the research findings to make a recommendation as to whether the state of Louisiana can adopt Streetlytics to provide supplemental AADTs for all its roadways.

OBJECTIVE

The primary objective of this study was to evaluate the accuracy of Streetlytics count data and to make a recommendation as to whether the state of Louisiana can adopt this tool to provide accurate AADTs for all its roadways, including state and non-state roads. Specifically, the main objectives were:

1) Conduct a review of Streetlytics to include a comprehensive detail of the capabilities of the tool, and how it can benefit the state of Louisiana
2) Develop a list of roadways, both state and non-state, within the Baton Rouge Metropolitan Area (BRMA) for which there are available traditional traffic counts.
3) Develop a suitable sample size based on statistical methods.
4) Obtain Streetlytics count data and corresponding Traditional count data for the selected sample.
5) Undertake a comparative analysis of the Streetlytics and Traditional count data, with the view to determine how comparable they are.
6) Make a recommendation as to whether Streetlytics can provide AADTs for the state of Louisiana based on the results obtained for BRMA and whether it offers more value than traditional methods.

SCOPE

The literature review on Streetlytics was conducted based on information obtained from the manufacturers, AirSage, and Citilabs. The study area was limited to Baton Rouge Metropolitan Area (BRMA), for which the research team obtained a Streetlytics research license for the use of the tool. Even though there are many features to Streetlytics, this study focused on only the AADT feature. The research team relied on DOTD's Traffic Monitoring unit to provide the Traditional count data for all roadways included in the sample. The Streetlytics license obtained was for the year 2015, so only sites that had publicly available Traditional count data for 2015 were selected for this study.

METHODOLOGY

The research team performed several tasks to achieve the study objectives. First, background information is presented to include literature on AADT estimation and a review of Streetlytics along with the capabilities of the product and how it may benefit the state of Louisiana. Second, the data collection effort is presented along with a description of the two types of data used for the study – Streetlytics count data and Traditional count data. Third, the methods used for the data analysis are discussed.

Background

Literature on AADT Estimation

The deployment of Intelligent Transportation Systems (ITS) technologies for calculating AADTs can pose a challenge for both urban and rural areas. Some state agencies employ traditional methods for AADT estimation such as on-site personnel, pneumatic counters or vehicle intercept surveys. Urban areas may also rely on historical data from turning movement studies, origin and destination studies, design estimates and projections, and MPO/municipal data obtained for other purposes. Today, state agencies are developing more advanced technology including remote sensory cameras, license plate reading technologies, GPS and Bluetooth detection technologies, etc. The deployment of these technologies is often expensive and is applied primarily to freeways and interstates in major metropolitan areas. These methods also tend to focus on small geographical areas at an instant.

According to Lowry et al. there are three primary areas of research on AADT estimation: “expanding short-duration counts to annual values, forecasting future-year counts from historical values, and spatially extrapolating counts from one location to another” *[2]*, *[3]*, *[4]*. Spatial extrapolation has been widely used and many studies have long been conducted in this area, most notably Mohamad et al., Anderson et al., Xia et al., and Zhao et al *[5]*, *[6]*, *[7]*, *[8]*. All these studies used characteristics of specific roadways and surrounding areas to create spatially transferrable models that utilized multiple linear regression to estimate AADT. The resulting R-squares for their models ranged from 0.60 to 0.82. Recently there have been a number of studies on a branch of spatial extrapolation, called kriging, which refers to cases where AADT is estimated for Unobserved locations (roadways for which no prior AADT observations have been recorded). Notable research has been performed in this area by various researchers *[9]*, *[10]*. These studies showed that the kriging technique could reduce average-absolute-error anywhere to between 16%-79%, and was more accurate than the earlier research methods. In line with this, Streetlytics utilizes the kriging technique to estimate AADT for all Unobserved roadways.

In an article, Ellison expressed that many current methods for calculating AADT are not very practical due to the excessive funds and resources required for their executions *[11]*. These methods obtain data that is analyzed later, rendering them obsolete when compared to more advance real-time data collection software. Because survey data only represents a point in time, information that is more useful can be derived from real-time data, which in turn creates a more meaningful understanding of traffic engineering problems. Traditional methods usually have limited geographical areas, are time consuming, and require significant personnel.

Overview of Streetlytics

Introduction

Streetlytics was developed through a partnership between AirSage (an Atlanta-based company that analyzes wireless cellular and GPS signaling data and provides real-time traffic information for location services and predictive analysis) and Citilabs (an international provider of transportation analytics, professional transportation planning solutions, predictive modeling, and traffic engineering Geographical Information Systems) *[12] [13]*, *[14]*. Figure 1 represents the amount of coverage that AirSage's cellular data collection process has across the United States. Streetlytics is designed on the Cube modeling platform, a software designed by Citilabs that allow users to query it for changes to the transportation network, land-use, and population characteristics of a region.

Four main components feed into the development of Streetlytics namely mobile phone carrier data (provided by AirSage), GPS device data (provided as probe data by HERE), mobile phone GPS data (mainly obtained from app developers), and traffic counts (both publicly available data and privately sourced data collection). Other data sources include census data, connected vehicles, navigation systems, employment tax records, building permits, postal delivery volumes, and many more. Figure 2 shows how these sources act as data input into the Streetlytics "Data Fusion Engine," its modeling platform, to result in movements for an entire population.

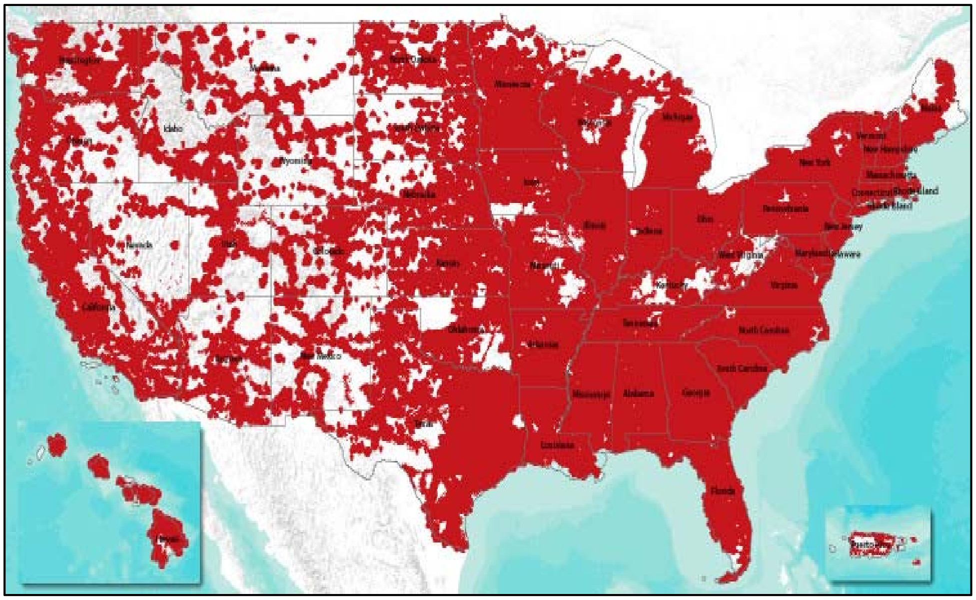

Figure 1
Airsage nationwide coverage

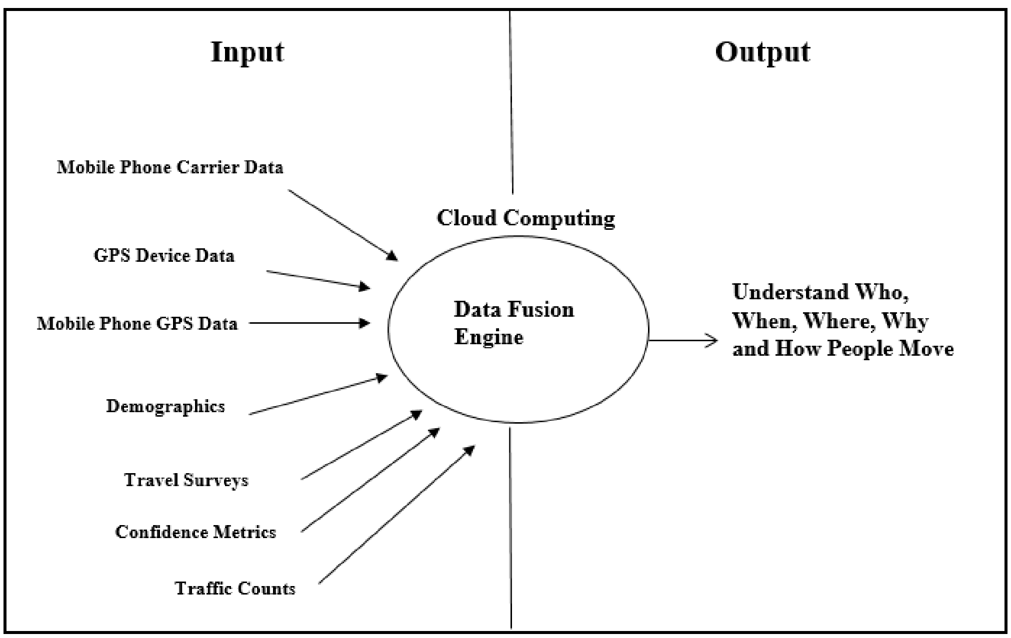

Figure 2
Streetlytics data fusion process

The main objective of the Streetlytics model is to understand an entire population in terms of knowing who are moving, when they are moving, where there are going, why they are moving and how they are moving on every roadway link. Some questions that can be answered by the model are:

- Who is on a roadway link by time of day, day of week, or month of year? What are their demographics? Who will be impacted by a project?
- When do travel patterns change by hour of the day, month, or season? When should construction begin?
- Where did trips begin and end? How can Transportation Demand Management strategies be improved?
- Why are people on the roadway? Is it for work, shopping, or other?
- How do people arrive in a specific location? What roadways were predominantly used to get there?

For the above reasons, Streetlytics is useful not only to transportation agencies, but also to planners, advertisers, developers, and any industry that seeks to understand movements within an entire population.

Features of Streetlytics

Streetlytics can be accessed in three different ways: web application, on-premises data, and data API (application program interface). Each of this feature is discussed below.

Web Application: The Streetlytics Web Application is accessed through any internet browser and provides access to volume maps, direction of flow, congestion levels, driver demographics, trip purpose, and trip patterns. For any road segment in the United States, the application can provide the following:

- Traffic volumes (morning peak, evening peak, off peak, daily)
- Predominant direction of traffic flow (morning peak, evening peak)
- Driver demographics (household income, household size, gender, age)
- ESRI Tapestry data that segments the population into 65 classifications
- Money maps that merges daily traffic volume with average household income
- Trip purpose maps (work, home, other) showing local and non-local trips
- Congestion patterns (morning peak, evening peak, off peak, daily)
- Trip pattern maps showing origin and destination (morning and evening peaks)

Figures 3 to 8 show screenshots of some of the previous features.

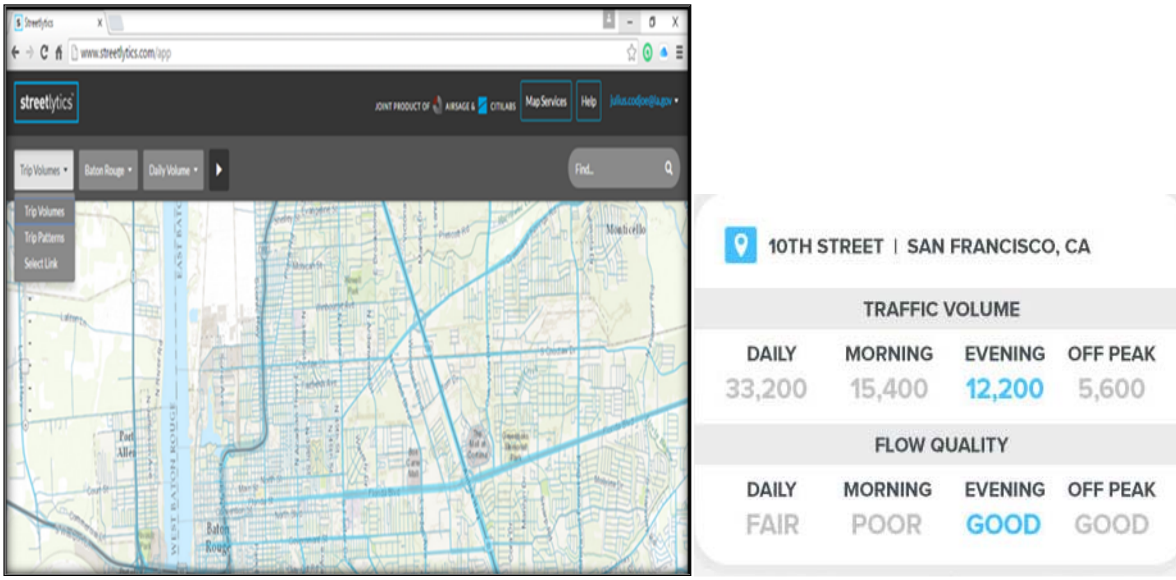

Figure 3

Trip map (varying line thickness associated with volumes) with subset showing volumes for a specific street

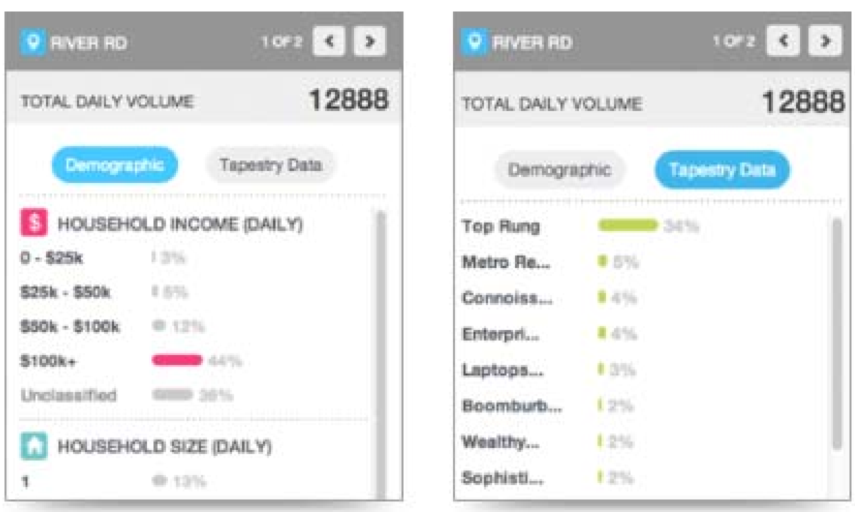

Figure 4

Demographic and ESRI tapestry data for a specific street

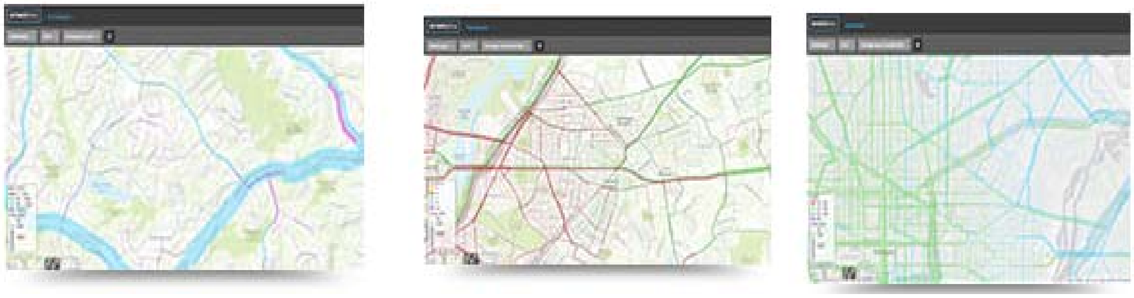

Figure 5

Maps showing average household income, average household size, and average age

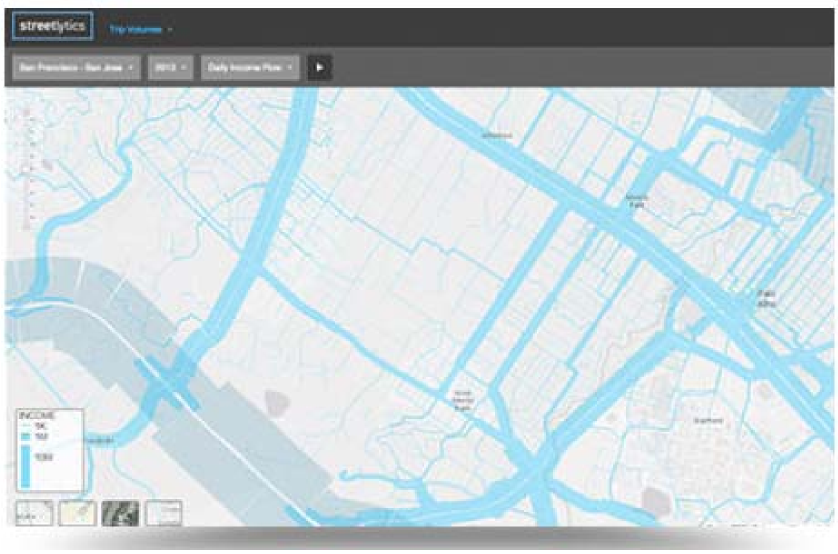

Figure 6

Daily household income flow

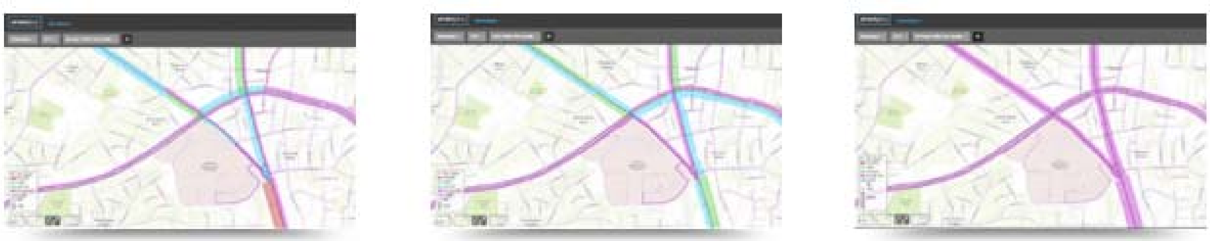

Figure 7

Congestion patterns for morning peak, evening peak, and off-peak

The “Trip Patterns” functionality addresses the movement of people. Figure 8 shows a visualization of trip patterns for Origin-Destination (O-D) between Census Block Groups by day but can be queried for morning, mid-day, evening peak, and off-peak period trips. Each point in Figure 8 represents 10 trips and the “point pattern thematic map” tool randomly scatters the appropriate number of points within an irregular shaped polygon forming a traffic analysis zone (TAZ) or Block Group that corresponds to a census block.

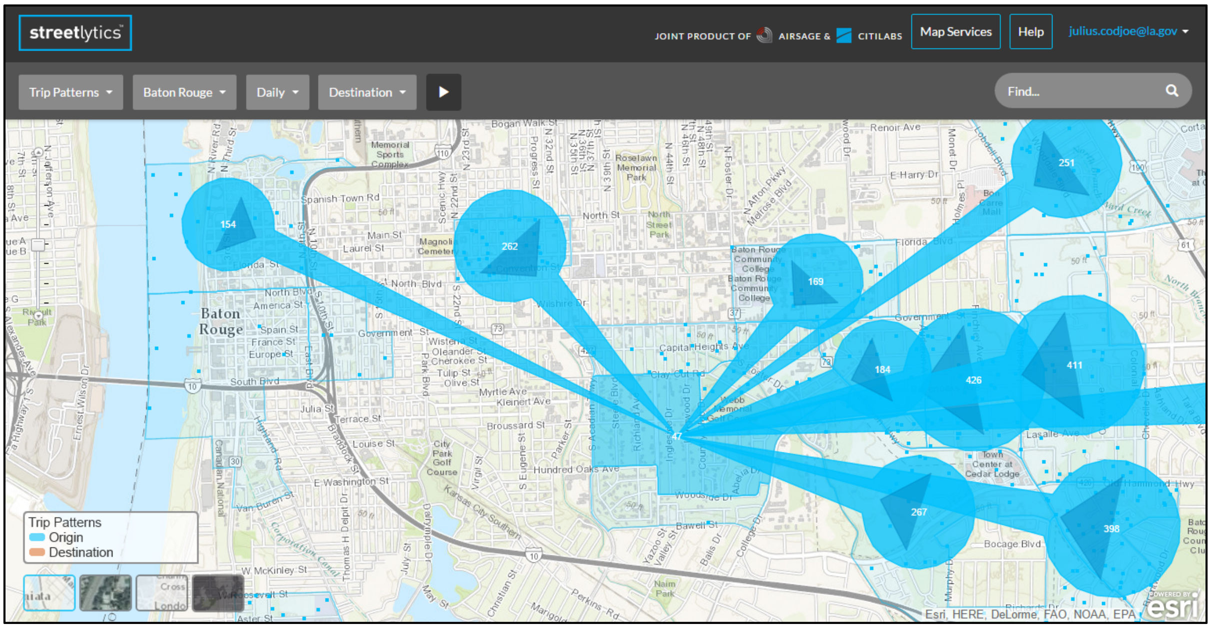

Figure 8
Trip patterns showing O-D for a defined census blocks

On-Premises Data: The Streetlytics data can be provided as a geodatabase or a shape file. It provides access to traffic volume, driver demographics, trip purpose, and trip patterns. In this form, it can be used in GIS software such as ArcGIS from ESRI. The data can also be accessed through ESRI map services. The On-Premises data option makes it possible to directly incorporate Streetlytics data in an establishment’s analytical processes. Data provided in the On-Premises solution includes Period-Specific Data Attributes, Average Daily Data Attributes, and Average Daily Travel Pattern Data, and each is further explained below.

1) Period-Specific Data Attributes

Data categorized under Period-Specific Data Attributes are provided by direction and for all roadways with a speed limit of 25 mph or greater. For each of the segments, the morning (7 am-10 am), evening (4 pm- 7pm) and off-peak (12 am – 7 am + 10 am – 4 pm + 7 pm -12 am) period data are provided. The information provided under Period-Specific Data attributes are Total Traffic Volume, Traffic Volume by Size of Household, Road Saturation Index, Traffic Volume by Age of Head of Household, and Traffic Volume by Household Income Class.

2) Average Daily Data Attributes

Data is provided for the average 24-hour day. Similar to the Period-Specific Data Attributes, data is provided by direction and for all roadways with a speed limit of 25 mph or greater. Additionally, ESRI Tapestry is provided as an optional add-on. Information provided include Traffic Volume by Travel Motivation (Commuting to and from work, commuting to and from education (University + School), other), Traffic Volume by Travel Type (Local travel and Non-local travel), and Traffic Volume by ESRI Tapestry Class *[15]*.

3) Average Daily Travel Pattern Data

Data for Average Daily Travel Pattern Data is provided at the US Census block group level. The data is provided for the average 24-hour day and includes:

- Table of Traffic Volume by Origin and Destination Pair
- Table of Traffic Volume by Home Location and Destination Pair

All the above are lumped and provided as a geo-database or shapefile. Users are able to directly query GIS maps and use the information extracted to answer specific questions on their transportation network.

Data API: Data Application Program Interface is the third and recent feature that Streetlytics can be made available. Data API allows users to easily incorporate all the Streetlytics insights (on-premises data attributes) into their own transportation, retail, Real Estate, out of home advertising or insurance applications. Therefore, this feature also provides access to traffic volume, driver demographics, trip purpose, direction maps, money maps, congestion and trip patterns.

Each of the three features described (web application, on-premises data, and data API), give Streetlytics the potential to become a powerful tool not only for DOTD but businesses, consumers and motorists in Louisiana. The demographics and income maps may help the private sector by providing tools for marketers and developers.

Data Description and Analysis

One of the objectives of this study was to develop an inventory of roadways within the Baton Rouge Metropolitan Area for which there is available Traditional count data that will be used for the comparative analysis. The research team, with the assistance of the Capital Regional Planning Commission (CRPC) of the Baton Rouge area, compiled a list of all roadways, classified into rural or urban areas, and showing the functional classification, the total length of each roadway, and its specific length within each parish it dwells. The comprehensive list has been included in Appendix A (Inventory of Roadways).

In order to generate a representative sample of roadways and for the purpose of analysis, all roadways were further stratified under two additional levels. The first was based on whether the count was a Routine count or a Permanent count. The second additional level classified the records based on whether they were at Observed or Unobserved locations. The following sub-section provides further information on the data collection effort.

Site Selection

The total list of roadways within the study area amounted to 113,760. A statistical method was used to estimate a 90% confidence level that the mean observations of AADT data for all 113,760 roadways can be represented by a minimum sample size of 270 roadways. The number roadways with AADT available for the year 2015 was 286. In this research, the 286 roadways were selected, then this number was reduced to 273 after outliers were removed. The size of 273 was used because increasing sample size increases the power of the results. The calculations were as follows:

a) Assuming percentage variability (P) = 50%

b) Z value for 90% confidence Level = 1.645

c) Assumed margin of error (D) = 5%

d) Finite Population Size (N) = 113,760
e) Sample size for infinite population:

$$(n_0) = Z^2\left[\frac{P(1-P)}{D^2}\right] = (1.645^2)\left[\frac{0.50(1-0.50)}{0.05^2}\right] = 270.6025 \qquad (1)$$

f) Sample size for finite population of size 113,760:

$$\frac{n_0}{1+\frac{n_0}{N}} = \frac{270.6025}{1+\frac{270.6025}{113,760}} = 269.962709 = 270 \quad (2)$$

g) Minimum sample size of roadways to be sample from each level:

$$\frac{\text{Size of Group}}{113,760} \times 270 \quad (3)$$

Figure 9 shows the hierarchy of sample groups, highlighting the three different levels for which the comparative analyses were undertaken. On level one, the data was first analyzed with no sub-groups. Researchers then elected to separate the Routine count data from the Permanent count data on level two for analysis. Routine count data refers to AADTs estimated using 48-hour short duration counts and Permanent count data refers to AADTs computed from data collected at Permanent count stations. It was hypothesized that since Permanent count data were taken for almost all the days in the year, the comparative analysis performed on it may produce better results than for analysis performed on Routine count data, especially since expansion factors have been applied to Routine count data. For the BRMA study area, five Permanent stations were available but only four of these stations had counts for both directions of traffic flow. Three stations were located in East Baton Rouge and the remaining two were from West Baton Rouge. Table 1 contains further information on the Permanent count stations used in this study. The sample sizes in each level created for the purpose of analysis are shown in Table 2. While geospatially matching the Permanent count data with the Streetlytics count data, it was Observed that all the Permanent count data were from Unobserved locations, i.e. locations for which Streetlytics had no prior AADT counts. Consequently, the Permanent count data stratum in Figure 9 has only one sub-level in Level 3. A list of all sampled roadways along with their Observed/Unobserved status, roadway location, and functional class is shown in Appendix A.

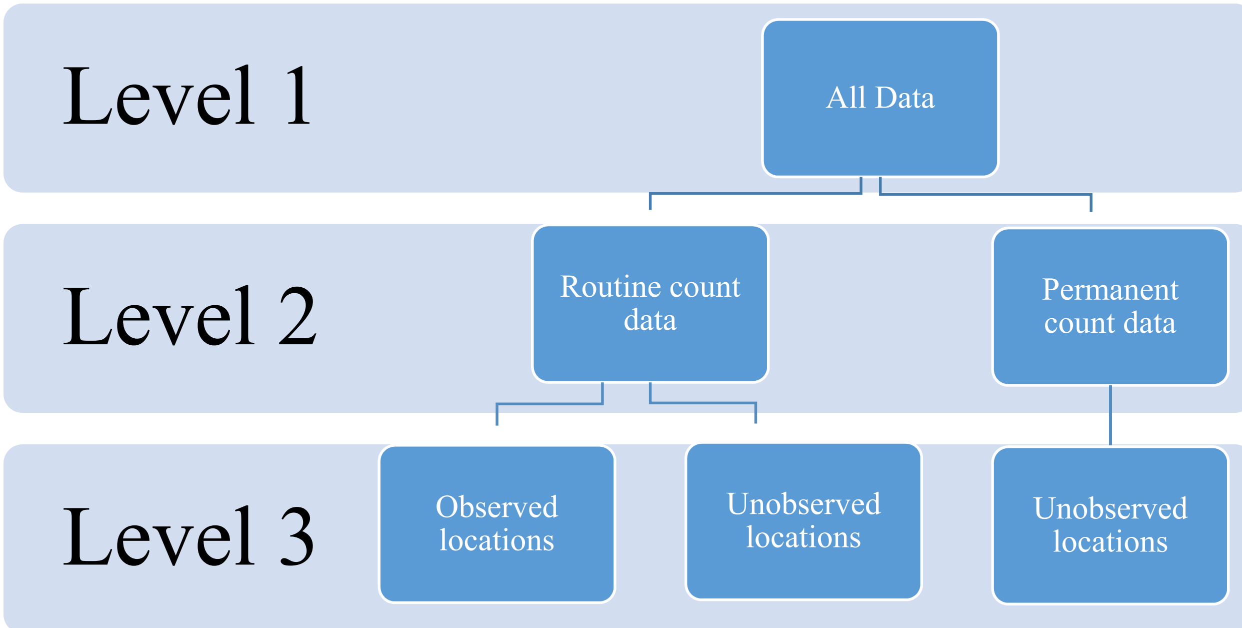

Figure 9
Hierarchy of sample groups

Table 1
List of Permanent count stations

Station ID	Primary Region	Route Number	Description	Dir. data available
4	East Baton Rouge	US0061	0.3 mi N of Chippewa St., Baton Rouge E B R	N
79	East Baton Rouge	I-0010	0.2 MILE SOUTH OF PECUE, BATON ROUGE	E, W
84	West Baton Rouge	I-0010	bet Bridge and La 415 Westport - WBR	E, W
2	East Baton Rouge	I-0110	1.6 mi. N. OF I-10 @ RR Overpass	E, W
16	West Baton Rouge	US0190	0.2 mi W of LA 415	E, W

Table 2
Sample sizes of stratified data

Analysis Level	Data category	Sample Size
1	All data	273
2	Routine count data	268
	Permanent count data	5
3	Routine count data (Observed locations)	83
	Routine count data (Unobserved locations)	185
	Permanent count data (Unobserved locations)	5

Streetlytics Data

Citilabs provided the Streetlytics count data in the form of a GIS geodatabase for the year 2015. The data was downloaded in a zip file through a link made available by Citilabs. In addition to the geodatabase file, a data dictionary was provided which contained the information presented in Appendix B. This data dictionary helped researchers to identify the fields to use in comparison to the Traditional count data. For the purpose of this study, only data relating to the field name TOTDATAP was used. This is described as the Total daily traffic.

The geodatabase file provided traffic data for every roadway within the Baton Rouge Metropolitan Area. To ensure that data for same locations were being compared, the Streetlytics count data and the Traditional count data for the year 2015 were joined geospatially using ArcGIS. The results from the spatial join were spot checked and validated to make sure there were no mismatching pairs. This was the first step to facilitate comparative analysis. The functional classifications of the selected roadways were: rural interstate roads, urban interstate roads, rural major collector roads, rural minor collector roads, urban collector roads, rural minor arterial roads, urban minor arterial roads, rural principal arterial roads, and urban principal arterial roads.

The Streetlytics data were classified by availability in an Observed or an Unobserved location. The Observed location subset was made up of roadway segments for which Streetlytics had prior traditional traffic count data; while the Unobserved location subset was made up of roadway segments for which Streetlytics did not have prior traditional traffic count data. Figure 10 shows the Streetlytics GIS layer which had a field “count” with binary responses (0 or 1), indicating whether the street was at an Observed or Unobserved location respectively. As described in earlier sections, Streetlytics was developed using data from a variety of observation sources including publicly available traditional traffic count data. The classification into Observed and Unobserved locations is significant in that the main benefits of Streetlytics will be realized in the Unobserved locations, since these are the areas for which there are no traditional traffic count data, and for which a state agency will have to undertake additional traffic data collection. However, whereas Streetlytics did not have prior traditional traffic count data for the Unobserved locations, the research team was able to find Traditional count data for 185 roadways in the Unobserved locations. These were used for the comparative analysis for the Unobserved locations. For the Observed locations, the research team however found much fewer available data for the year 2015, resulting in 95 roadways.

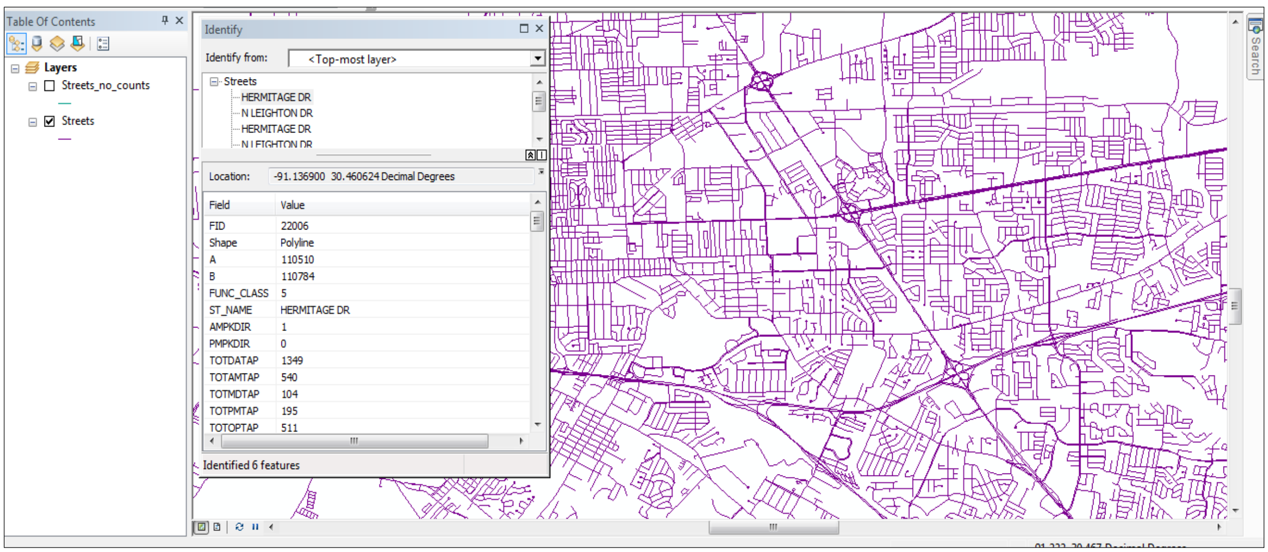

Figure 10
Streetlytics GIS layer

Traditional Count Data

Traditional count data comprises "Routine count data" and "Permanent count data" for the Baton Rouge Metropolitan Area for the year 2015, since the data available for Streetlytics was only for the year 2015. Routine count data refers to AADT generated from 48-hour short duration routine traffic counts that are collected by DOTD's Traffic Monitoring Unit on a 3-year cycle from approximately 4,200 sites statewide (approximately 1,400 sites each year for one-third of the state). The AADT values are estimated by applying correction factors generated from approximately 60 Permanent count stations, spread statewide, which collect data continuously each day in a year *[16]*. However, due to maintenance, weather, and other technical factors, not all stations are able to collect data 365 days in the year. These stations tend to have varying coverage with very few being able to have a 100% coverage for a given year. Out of the 60 Permanent count stations, there are approximately 15 vehicle loop detector sites and approximately 45 radar sites (Remote Traffic Microwave Sensor -RTMS). Figure 11Figure 11 displays the locations of the Permanent count stations in Baton Rouge (green dots).

Figure 12 is an illustration of the Routine count data on DOTD's website with data for a selected parish represented with red dots. The open dialog box contains the information provided for a selected route (LA0037), in this case, historical data of AADT every three years from 1999 to 2014. The Routine count data from Louisiana contain information on the route names, highway numbers, number of lanes, geographic coordinates, posted speed limit, year data was collected with the corresponding AADT data which ranges from 1986 to the year 2015. Each road, however, has AADT data for no more than six of the years within the aforementioned range.

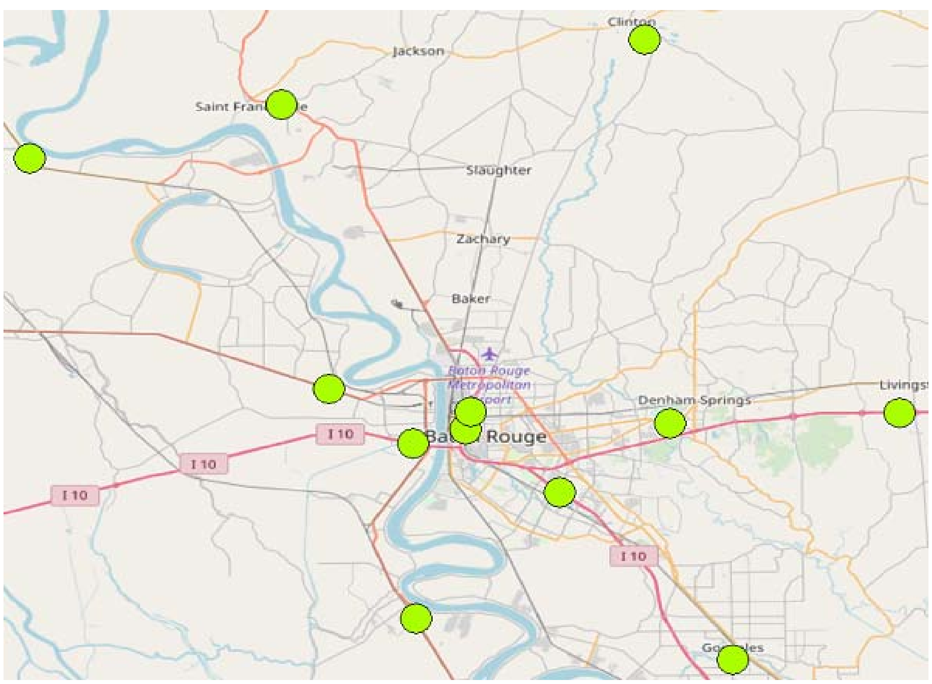

Figure 11
Permanent count stations in Baton Rouge Metropolitan Area

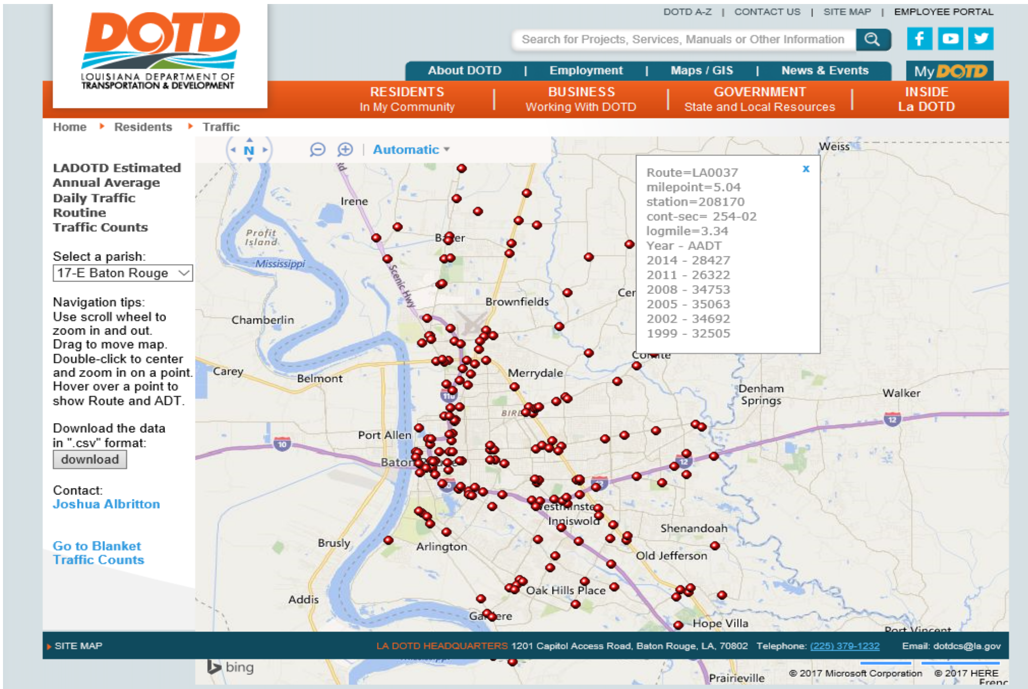

Figure 12
Routine count stations in East Baton Rouge parish

Data Analysis

Outlier Detection and Removal

Outliers are extreme scores that differ considerably from the majority of scores *[17]*. Hawkins defined an outlier as an observation that deviates so much from other observations as to arouse suspicion that it was generated by a different mechanism *[18]*. The presence of outliers could possibly distort the data analysis procedure hence outlier detection and removal was performed as a precautionary step in analyzing the data.

The first step of detecting outliers in this research was the standardization of the observations or data points. The standard score obtained by standardization is defined as the signed number of standard deviations by which the value of an observation is above the mean value of what is being Observed or measured in statistics *[19]*. Standard scores, which are dimensionless quantities are also called z-values, z-scores, and standardized variables. Subtracting the population mean from an individual raw score and then dividing the difference by the population standard deviation produces the z-score *[19]*. Observations above the mean have positive z-scores and those below the mean have negative z-scores. Observations that had z-scores of plus or minus three (±3) were considered as outliers as suggested by Stevens *[20]*. The sample size was reduced to 273 from 286 after the outliers were removed. Figure 13 and Figure 14 show plots of data points before and after the outlier detection and removal.

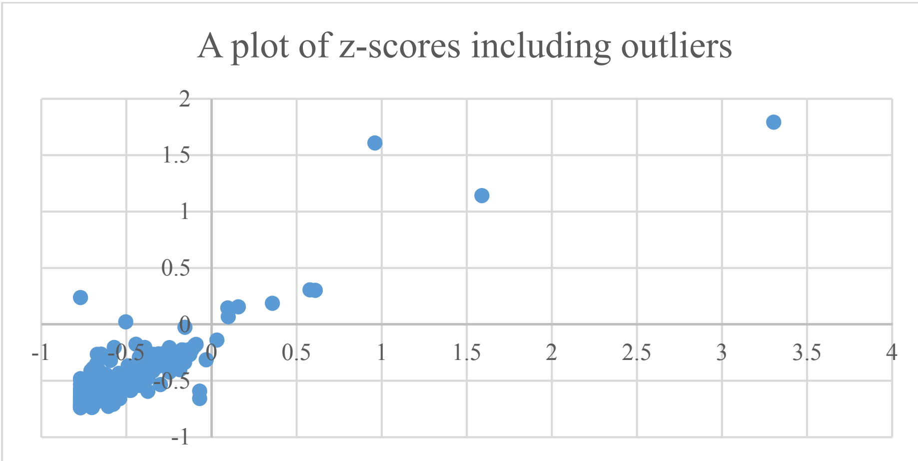

Figure 13
A plot of z-scores including outliers

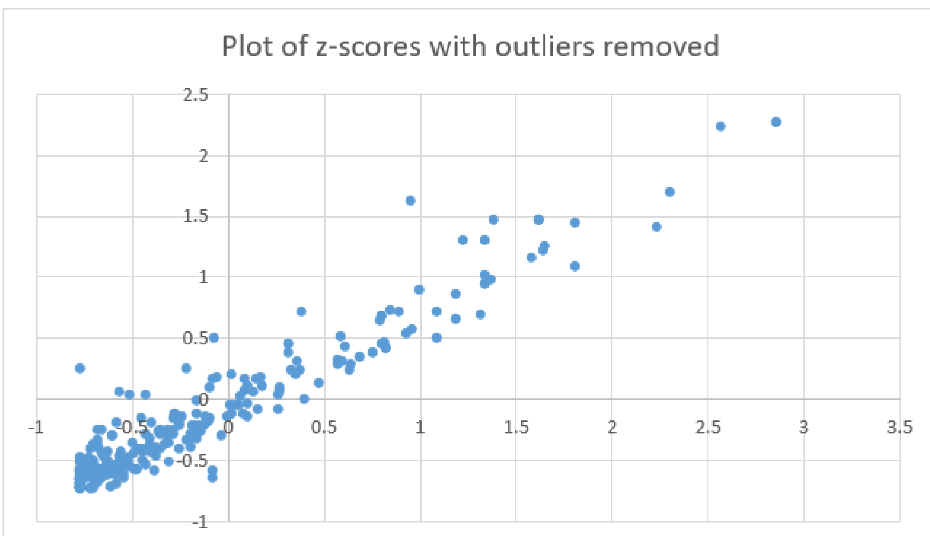

Figure 14
Plot of z-scores with outliers removed

Bivariate Correlation

Correlation is used to assess the degree of association or relationship between variables *[17]*. Bivariate correlation involves investigating the relationship between two (bi-) variables. The two variables are usually a pair of observations *[21]*. The relationship between any two variables varies from strong to weak or could be none. When the relationship is strong, knowing the value of one observation helps predict the value of the other observation in the pair. In other words, high values of variable A are likely to have comparable high values on variable B *[21]*. This would be considered a strong positive correlation. A feature of the correlation coefficient (Pearson r) is that it can only range from –1.00 to +1.00. Values obtained outside this range are invalid. Once the correlation coefficient approaches r = +1.00 (or is greater than r = +.50) it can be interpreted that there is a strong positive relationship or high degree of relationship between the two variables. When it approaches r = -1.00 (or less than r = -.50), it means that there is a strong negative relationship. When the correlation coefficient is close to r = 0.00, knowing the value of variable A tells nothing about the value of variable B. The correlation coefficient is reported to two decimal places *[21]*.

In this research, scatterplots were produced to determine the relationship between the two groups of data. When using the Pearson correlation coefficient, it is assumed that the cluster of points is best fit by a straight line *[21]*. An indication of a positive relationship would be the production of a best-fitting line that slopes from the lower left of the graph to the upper right. A weak/no relationship would produce a random cluster of points and a perfect correlation (r = 1.00) would produce a scatterplot where the best-fitting straight line passes through all of the points which is unlikely in the world of real data *[21]*. Prediction ellipses were overlaid on the scatterplots produced. A prediction ellipse gives a visual indication of skewness in the data and displays linear correlation. A skinny ellipse indicates highly correlated variables, whereas nearly circular ellipses indicate little correlation *[21]*.

Bivariate correlation was used in this research to investigate whether there was a strong positive relationship between the Traditional count data and the Streetlytics count data. A correlation can only indicate the presence or absence of a relationship, but not the cause of the relationship. A strong correlation will benefit from a linear regression analysis that will measure how strongly one variable can cause a change in the other.

Percentage Difference

The percentage difference between the pairs of observations from the Streetlytics count data and the Traditional count data were calculated to identify the extent to which the pairs of observations differed from each other. Percentage difference was chosen over percentage error because the use of the term “error” would mean that one dataset contained perfect data but in this research, both datasets contain estimates of AADT. The formula used to calculate the percentage difference is:

$$\text{Percentage difference} = \left|\frac{\text{Traditional} - \text{Streetlytics}}{(\text{Traditional} + \text{Streetlytics})/2}\right| * 100\% \qquad (4)$$

Simple Linear Regression

The use of a linear function or straight line to predict one quantitatively measured variable based on the values of another quantitatively measured or dichotomously coded variable is a procedure called Simple Linear Regression *[17]*. The fitting process is technically referred to as ordinary least squares, in which the sum of the squared distances between the data points and the linear function is the minimum value possible *[17]*.

The variable which is being predicted is called the dependent variable(Y) which is the Streetlytics count data in this research. The variable used as the basis of prediction is called the independent variable(x) which is the Traditional count data in this study. The simple linear regression procedure produces Parameter estimates for the intercept and the independent variable (Traditional count data). These parameter estimates are used in modelling the Traditional count data to the Streetlytics data. It is a measure of how a change in Traditional count data will affect the Streetlytics data, thereby providing the degree of association between the two datasets.

The R-square and Adjusted R-square outputs of the simple linear regression procedure are of utmost relevance. The R-Square is the squared multiple correlation. It describes the amount of variance of the dependent variable that is accounted for by the prediction model *[17]*. The R-square is adjusted to account for the fact that regression capitalizes on chance. This is shown by the Adjusted R-square statistic *[17]*.

DISCUSSION OF RESULTS

Comparative analyses were undertaken for each of the levels shown in Figure 9 and Table 2. For each level, bivariate correlation analysis was undertaken to first determine the degree of association between the Traditional count data and Streetlytics count data. Secondly, the percentage difference between the sets of data were calculated to assess how the means differ. Lastly, a simple linear regression was modeled at each level to determine whether the differences between the observations can be accounted for through statistical models. The subsections below present the findings for each level, followed by a discussion on the cost of Streetlytics, and then the benefits of acquiring the Streetlytics count data as a supplement to the Traditional count data.

Results of Data Analysis for Level 1: All Data

Bivariate Correlation

The strong positive linear relationship between the Streetlytics data and the Traditional count data for all the roads/observations analyzed was shown by a correlation coefficient of 0.95 in the bivariate correlation analysis which is further illustrated in Figure 15 with an elongated prediction ellipse. This result means 95% of the variation in mean Traditional count data for all the roadways can be predicted from the relationship between Streetlytics count data and the Traditional count data; conversely, only 5% of the variation in Traditional count data cannot be explained. The positive correlation coefficient means that for roadways with increasing Traditional count data, the Streetlytics counts also increases; and conversely, as one decreases, the other decreases. The analysis also reported a p-value of <.0001, indicating a statistically significant correlation. This highlights the potential for Streetlytics to provide counts which are comparable to the Traditional count data for all Observed roadways.

Percentage Difference

Percentage differences were calculated for the following Traditional count data ranges for AADT: >0, >50, >150, >300, >500, >1000, >1500, >3000, >4000, >5000, >7000, >10000 vpd. Using such AADT ranges will account for differences between rural vs. urban, and collectors vs. arterials vs. local roads, since AADT values are the primary differentiators for these categories in this study. These percentage differences are illustrated in Figure 16. A general downward trend in percentage difference can be seen from the graph indicating that the comparability of Streetlytics count data to Traditional count data increases with increasing AADT values. The average percentage difference for all the data was 44%, with generally Streetlytics count data showing lower AADT values. Also, the largest percentage difference is Observed when roads with AADT greater than 50 vpd are included in calculating these percentage differences. Table 3 shows the percentage of data in each category. It can be seen that 10% of the Traditional count data analyzed fall under 300 vpd while only about 3% of the data falls under 50 vpd. Streetlytics currently have their minimum AADT value set at 300 vpd. The percentage difference between the two datasets for Traditional count data 300 vpd and above is 37.08% while that for under 300 vpd is 110.38%. This indicates that it would be prudent for Streetlytics to set the minimum volume to 50 vpd instead of 300 vpd to make the two sets of data more comparable.

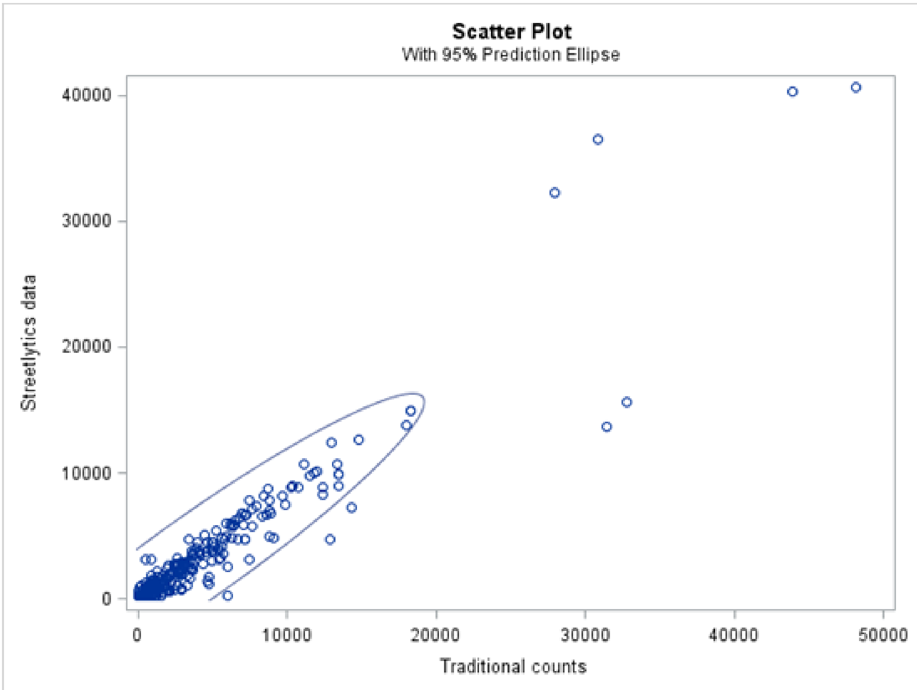

Figure 15
Scatterplot for all data

Table 3
AADT ranges with percentage of data and average percentage difference (all data)

AADT Range	Percentage of data	Average Percentage difference	Dataset with higher AADT values
>0	100%	44.50%	Traditional
>50	97%	40.71%	Traditional
>150	92%	37.36%	Traditional
>300	90%	37.08%	Traditional
>500	86%	37.18%	Traditional
>1000	72%	33.83%	Traditional
>1500	61%	32.31%	Traditional
>3000	43%	27.85%	Traditional
>5000	27%	27.43%	Traditional
>7000	17%	26.94%	Traditional
>10000	9%	28.77%	Traditional

Simple Linear Regression

A simple linear regression was calculated to predict the value of a Streetlytics count data point based on Traditional count data. A significant regression equation was found ($p<0.001$) with an R^2 value of 0.9, meaning the model is able to explain 90% of the variation in the Traditional count data. The regression equation equating Streetlytics count data (SD, vpd) to Traditional count data (TCD, vpd) is:

$$\mathrm{SD} = 16 + 0.80995\mathrm{TCD}\ (\mathrm{R}^2 = 0.9, \mathrm{p} - \mathrm{value} < 0.001) \qquad (5)$$

The results show a strong positive and significant relationship, indicating that in general, increasing Traditional count data by 1 vpd will result in an increase of Streetlytics count data by 0.80995vpd. Figure 17 shows a plot of the results for the model fit between Streetlytics count data and the Traditional count data. The strong bivariate correlation and the significant coefficient of regression between the two datasets validates the use of Equation (5) in predicting Streetlytics AADTs from Traditional AADT. The parameter coefficient of 0.80995 shows how comparable the two sets of data are in terms of using one to predict the other. Furthermore, Figure 18 shows that the fitted Streetlytics data points are not systematically too high or too low anywhere in the observation space; rather, the residuals are randomly scattered around zero. This attribute renders the model unbiased, meaning the regression model fits the data well with accurate coefficient estimate (0.80995) and predictions (SD).

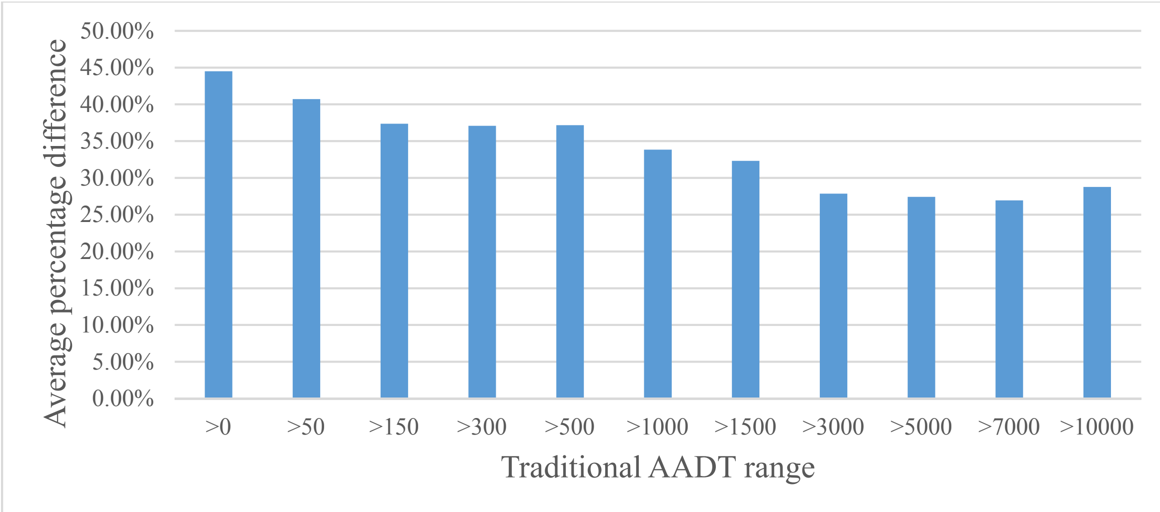

Figure 16
Distribution of percentage differences across different AADT ranges (all data)

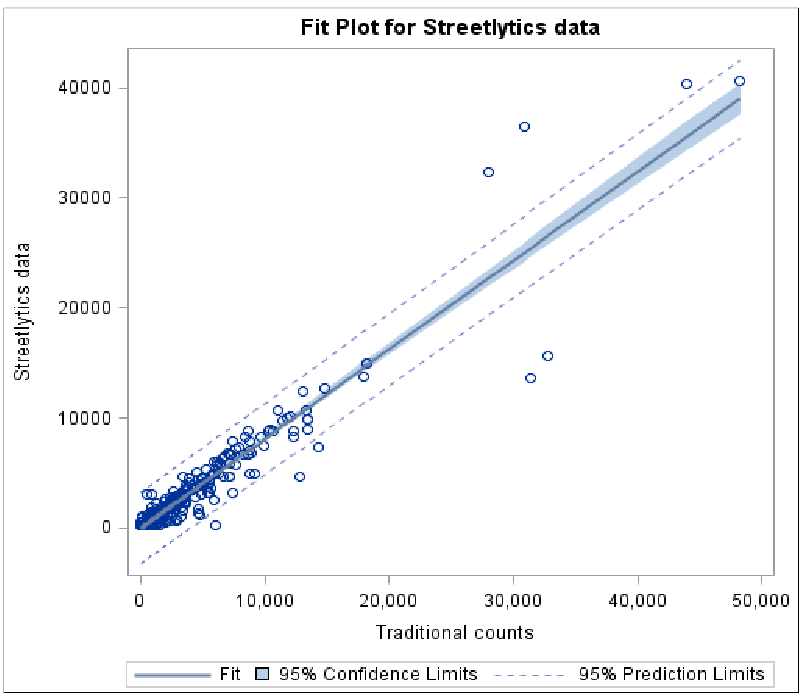

Figure 17
Regression results (all data)

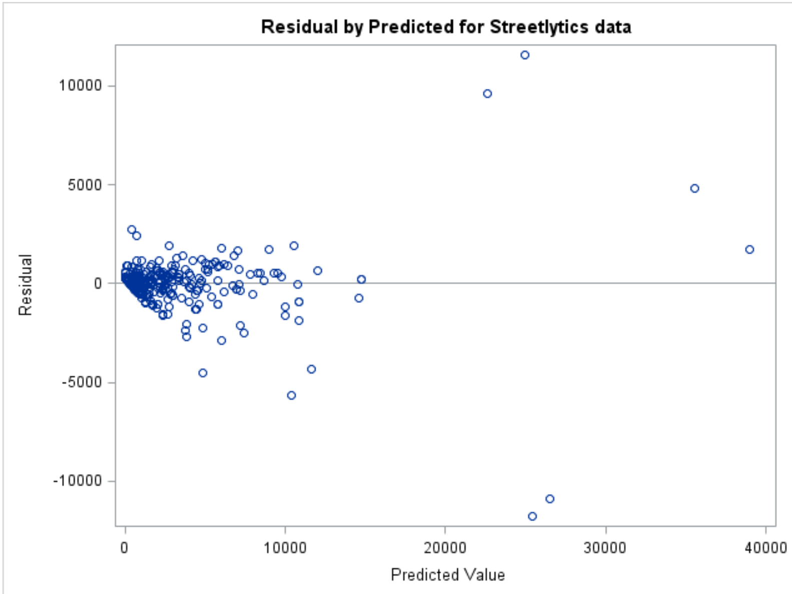

Figure 18
Residuals vs. Streetlytics data (all data)

Results of Data Analysis for Level 2: Routine and Permanent Count Data

Analysis in this level was done separately for Routine and Permanent count data. Bivariate correlation, percentage difference analysis and simple linear regression were performed on the Routine count data. Due to restrictions in sample size (n = 9, 5 roads) of the Permanent count data, bivariate correlation and linear regression could not be performed on the data since the power of the study (its ability to detect an effect when there is one to be detected) would be reduced and increase the chances of making wrong conclusions. Percentage differences were however calculated for the Permanent count data and are presented in the write-up.

Routine Count Data

Bivariate Correlation. The correlation coefficient of 0.96 obtained from bivariate correlation analysis of the Routine count data indicates that there is a strong positive relationship or high degree of relationship between the Streetlytics count data and the Traditional count data. This is highlighted by the skinny/elongated ellipse (shown in Figure 19) indicating highly correlated variables. It can be inferred that the Streetlytics count data is robust and versatile and has a great potential to provide counts which are comparable to the Traditional count data.

Percentage Difference. Similar to the results obtained from performing the same analysis on all the data, there is a general downward trend observed in the distribution of percentage differences across different AADT ranges for Routine count data (Figure 20). The average percentage difference for the Routine count data was 45.01%, with generally Streetlytics count data showing lower AADT values as shown in Table 4. Traditional count data with AADTs of 300 vpd and above comprised 90% of the data with an average percentage difference of 37.03% (generally higher AADT values for Traditional count data) while that for under 300 vpd is 110.38% (generally higher AADT values for the Streetlytics count data). These results, in addition to those which were obtained for analyzing all the data strongly buttress the suggestion that setting the minimum volume to 50 instead of 300 will give more comparable Streetlytics count data to the Traditional count data.

Simple Linear Regression. A simple linear regression was calculated to predict the values of Streetlytics count data points from Traditional count data points. A significant regression equation was found ($p<0.001$) with an R^2 of 0.92. The regression equation equating Streetlytics count data (SD, vpd) to Traditional count data (TCD, vpd) is:

$$\mathrm{SD} = 93 + 0.77966\mathrm{TCD}\ (\mathrm{R}^2 = 0.9, \mathrm{p} - \mathrm{value} < 0.001) \tag{7}$$

Figure 21 shows a plot of the results for the model fit between Streetlytics count data and the Traditional count data (Routine count data). The strong bivariate correlation and the significant coefficient of regression between the two datasets validates the use of equation (7) in predicting Streetlytics AADTs from Traditional AADT. Also, Figure 22 shows that the fitted Streetlytics data points are not systematically too high or too low and the residuals are randomly scattered around zero, showing that the model is unbiased.

As explained for the “All Data,” this represents a very good model fit and it shows that the Traditional count data can be used to accurately predict the Streetlytics count data, with 90% of the variability in the data accounted for.

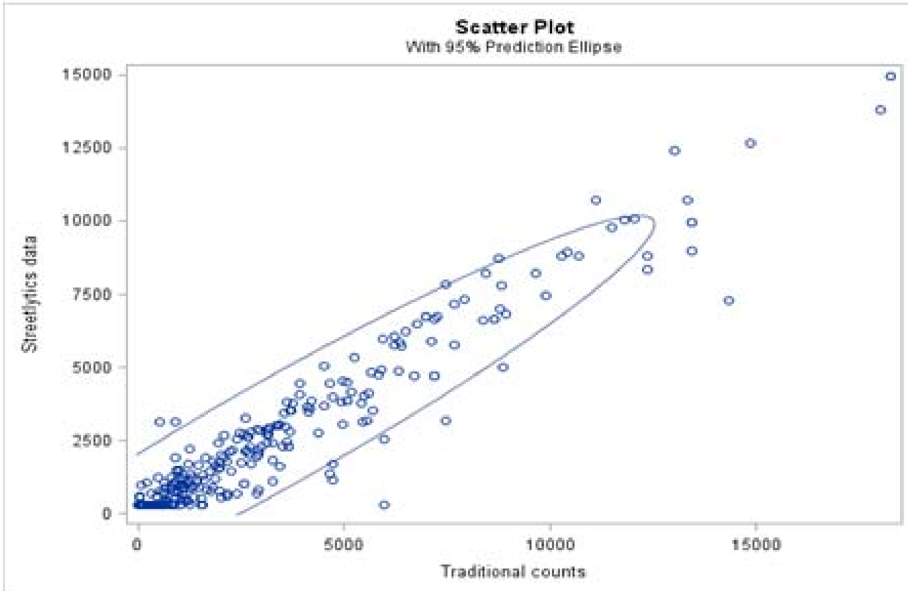

Figure 19
Scatterplot of the Routine data

Table 4
AADT ranges with percentage of data and average percentage difference (Routine Count Data)

AADT Range	Percentage of data	Average Percentage difference	Dataset with higher AADT values
>0	100%	45.01%	Traditional
>50	97%	41.00%	Traditional
>150	93%	37.03%	Traditional
>300	90%	37.03%	Traditional
>500	85%	37.03%	Traditional
>1000	71%	33.10%	Traditional
>1500	60%	32.00%	Traditional
>3000	41%	27.02%	Traditional
>5000	25%	25.00%	Traditional
>7000	15%	23.12%	Traditional
>10000	7%	24.00%	Traditional

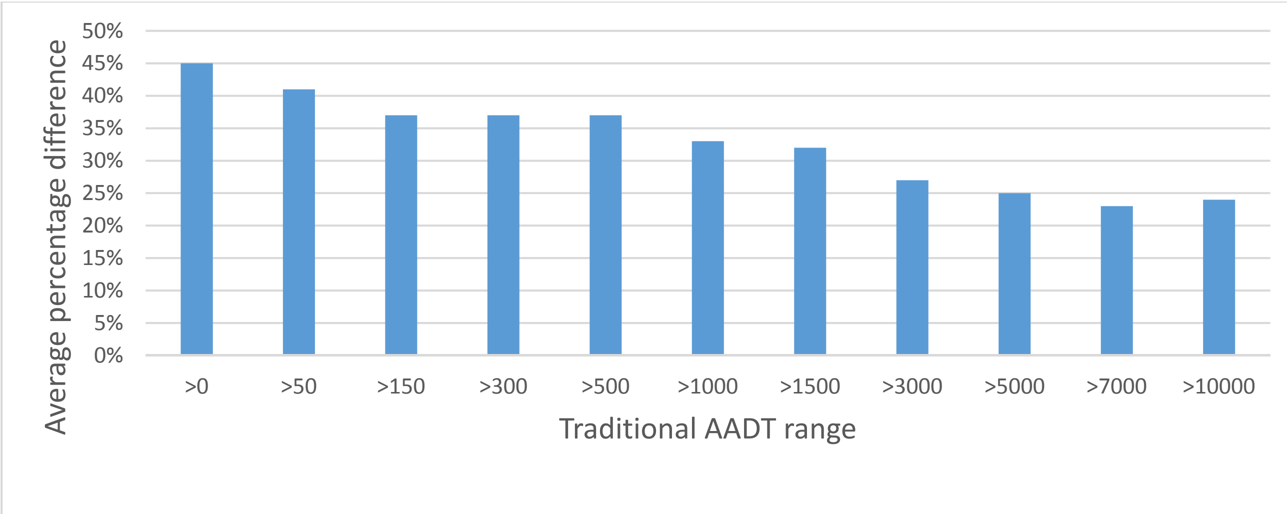

Figure 20
Distribution of percentage differences across different AADT ranges (Routine count data)

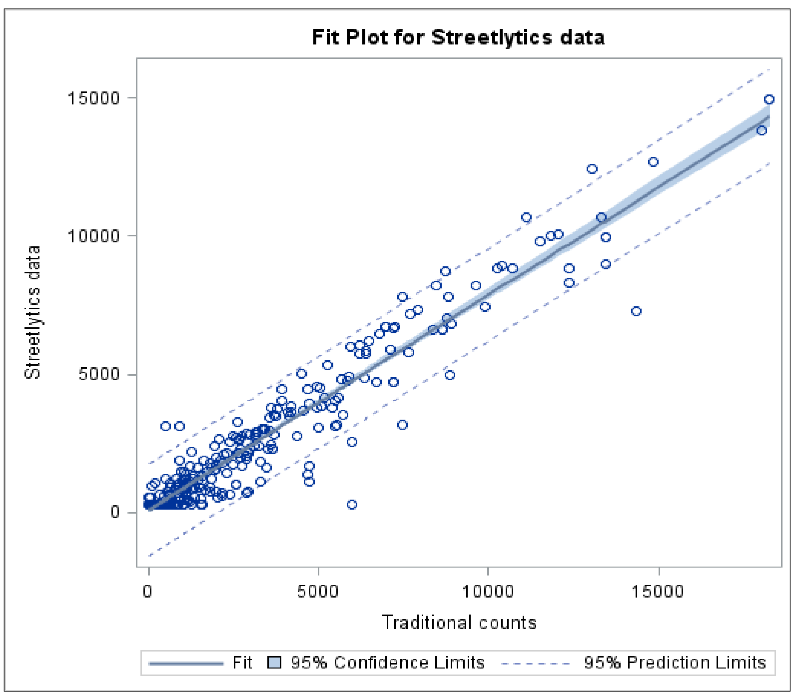

Figure 21
Regression results for Routine count data

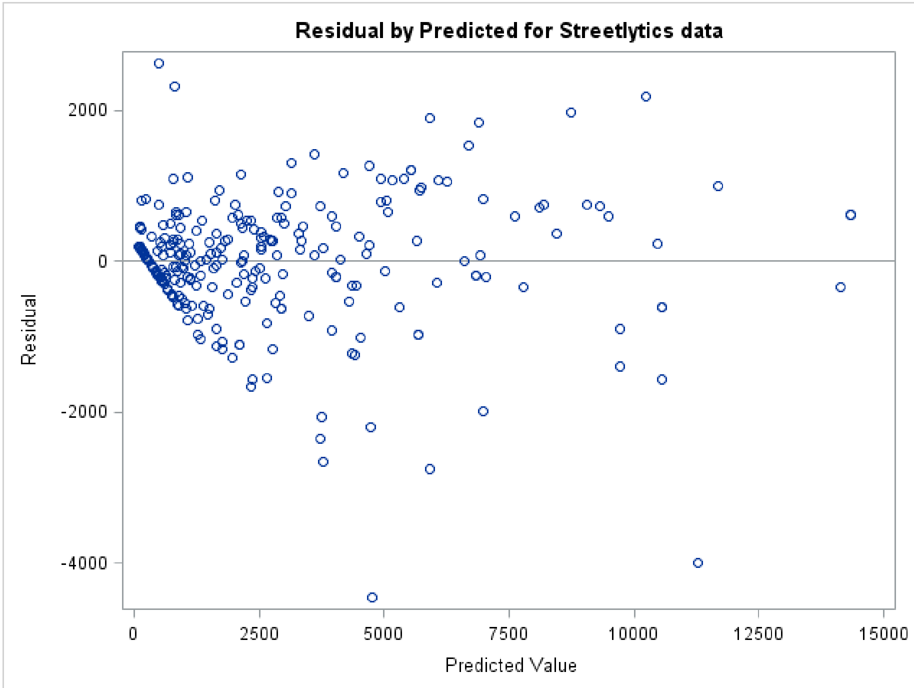

Figure 22
Residuals vs. Streetlytics data (Routine Count Data)

Permanent Count Data

Percentage Difference. Data from five Permanent count stations in Baton Rouge are used for the percentage difference analysis in Table 5. Most of the selected stations with available counts were those that had more than 70% coverage for the year 2015. Percentage differences for all the pre-determined ranges were not calculated due to the small sample size. Table 5 contains information about the percentage differences obtained for each station and for both directions of traffic. Data was available for only one direction at Station 4. The "Percentage of coverage" in the table refers to the percentage of days (out of 365 days) that the Permanent count station was collecting data. From a visual inspection, the results indicate that the percentage difference obtained does not depend on the Percentage of coverage of the Permanent count station. For instance, Station 84 had 98% coverage yet the percentage difference obtained was more than 70%, likewise, Station 79 had 98% coverage but had 9% and 17% percentage differences.

Table 5
Percentage differences for Permanent count data

Station ID	Route Number	Direction	Percentage difference	Percentage of coverage	Dataset with higher AADT values
4	US0061	N	31.01%	77%	Streetlytics
79	I-0010	W	9.05%	98%	Traditional
79	I-0010	E	17.10%	98%	Traditional
84	I-0010	W	71.23%	98%	Traditional
84	I-0010	E	79.30%	98%	Traditional
2	I-0110	E	17.04%	28%	Streetlytics
2	I-0110	W	14.14%	28%	Streetlytics
16	US0190	E	61.11%	82%	Traditional
16	US0190	W	93.00%	82%	Traditional

The average percentage difference for Permanent count data was 43.00% (Traditional count data generally showing 50% more higher AADT values), very similar to that of the Routine count data (45.01%). This result was initially surprising as the research team had expected the data from the Permanent count stations to be more comparable to the Streetlytics count data. It was hypothesized that due to the many computations involved in developing AADTs from the Routine count data, those would show higher percentage differences with the Streetlytics count data than for the Permanent counts data which supposedly, will involve little or no computations. The research team however noted that all the Permanent count data were from Unobserved locations while the Routine count data were from both Observed and Unobserved locations. In that vein, a more comparable estimate of percentage difference to the results for the Permanent count data will be that estimated for Unobserved locations (routine count data). This is undertaken in the Level 3 analysis in the next section.

Results of Data Analysis for Level 3: Observed and Unobserved Locations

Analysis on Level 3 was done for only Routine counts because it was observed that all Permanent count data were obtained from Unobserved locations, hence performing analysis on these counts would be a repetition of the analysis done in Level 2. As mentioned earlier, Observed locations refer to roadway segments for which Streetlytics had prior traditional traffic count data; while the Unobserved locations were made up of roadway segments for which Streetlytics did not have prior traditional traffic count data. Since Streetlytics count data is supposed to supplement Traditional count data and provide AADT estimates where no Traditional count data exists, it is important to compare the rates for the Unobserved and Observed locations. The following subsections reports results obtained for the bivariate correlation analysis, percentage difference analysis, and the simple linear regression analysis.

Bivariate Correlation. Observed locations reported a higher correlation coefficient of 0.94 (Figure 23) than Unobserved which reported a correlation coefficient of 0.85 (Figure 24) locations after analysis. This was to be expected since the producers of Streetlytics count data had access to traffic counts at Observed areas so the data was more likely to be comparable to the Traditional count data after their data optimization process. However, the difference in Observed correlation coefficients is not significant.

Percentage Difference. From Figure 25, it can be seen that Observed locations had fairly constant percentage differences for AADT ranges under 5,000 vpd. Figure 26, shows that Unobserved locations had decreasing percentage differences with increasing AADT values over the aforementioned ranges, but with higher percentage differences than for Observed locations. This was to be expected since the Streetlytics count data for Observed locations were made by factoring in the Traditional count data.

Table 6 shows the percentage of data in each category. It can be seen that 100% of the data from Observed locations had a minimum AADT of 3000 vpd and reported a percentage difference of 23.60%. On the contrary, Table 7 shows the average percentage difference for Unobserved locations was 53.90% (110.38% for data with AADT<300 vpd and 44.50% for AADT ≥ 300). Streetlytics count data generally showed lower AADT values for both Observed and Unobserved locations. It can also be seen that the 43.00% percentage difference reported for the Permanent count data (Unobserved locations) was a slightly better result than the 53.90% obtained for the Routine count data (Unobserved locations).

A similar study was reported by FHWA in 2016 where data from Permanent stations was used as the ground truth and compared against AADT estimations from 48hr counts*[22]*. They had percentage differences from 22% to 25%. This compares to the 23.60% percentage difference obtained for Routine count data (Observed locations). It is worth noting that for the FHWA study, researchers took the 48-hr. counts from the same locations as the Permanent counters and still reported an error rate comparable to that obtained in this study when AADTs generated from 48-hr. counts are compared to Streetlytics data (at Observed locations).

Simple Linear Regression. A simple linear regression was calculated to predict the value of a Streetlytics count data point based on Traditional count data in Observed and Unobserved locations. Significant regression equations were found for both study areas ($p<0.001$) with an R^2 of 0.73 and 0.88 for Unobserved and Observed locations respectively.

The regression equation equating Streetlytics count data (SD, vpd) to Traditional count data (TCD, vpd) for Observed locations is:

$$\mathrm{SD} = 106 + 0.8\mathrm{TCD}\ (\mathrm{R}^2 = 0.9, \mathrm{p-value} < 0.001) \quad (8)$$

The regression equation equating Streetlytics count data (SD, vpd) to Traditional count data (TCD, vpd) for Unobserved locations is:

$$\mathrm{SD} = 275 + 0.6\mathrm{TCD}\ (\mathrm{R}^2 = 0.7, \mathrm{p-value} < 0.001) \quad (9)$$

It can therefore be said that, Streetlytics data increased by 0.8 and 0.6 for each vehicle recorded in the Traditional count data in Observed locations and Unobserved locations respectively. Table 8 summarizes Correlation, Percentage difference, and Regression statistics for Observed and Unobserved locations, and for reference, includes the statistics for all data. The R^2 values obtained for the statistically significant models obtained from regression analysis for both Observed and Unobserved locations were approximately 0.9. It was realized that the average percentage difference for Unobserved locations was about 20% higher than what was obtained for Observed locations (Routine Counts).

Figure 27 and Figure 28 shows a plot of the results for the model fit between Streetlytics count data and the Traditional count data (Observed and Unobserved locations). The strong bivariate correlation and the significant coefficient of regression between the two datasets validates the use of equations (8) and (9) in predicting Streetlytics AADTs from Traditional AADT. Furthermore, Figure 29 and Figure 30 shows that the fitted Streetlytics data points are not systematically too high or too low and the residuals are randomly scattered around zero, showing that the model is unbiased.

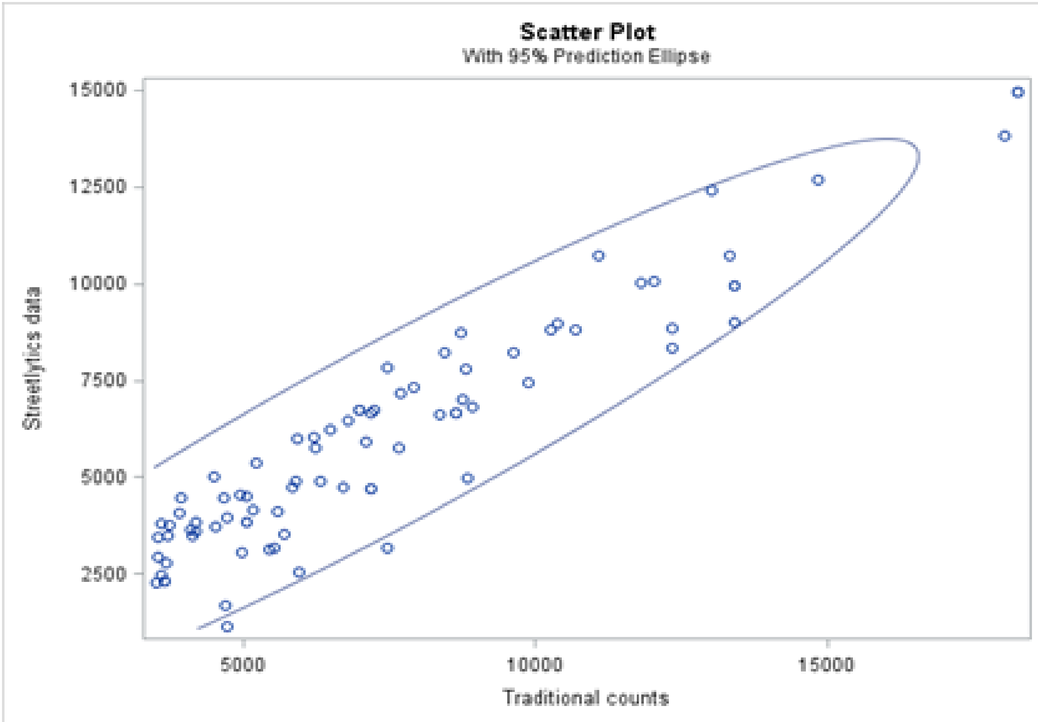

Figure 23

Scatterplot of data from Observed locations

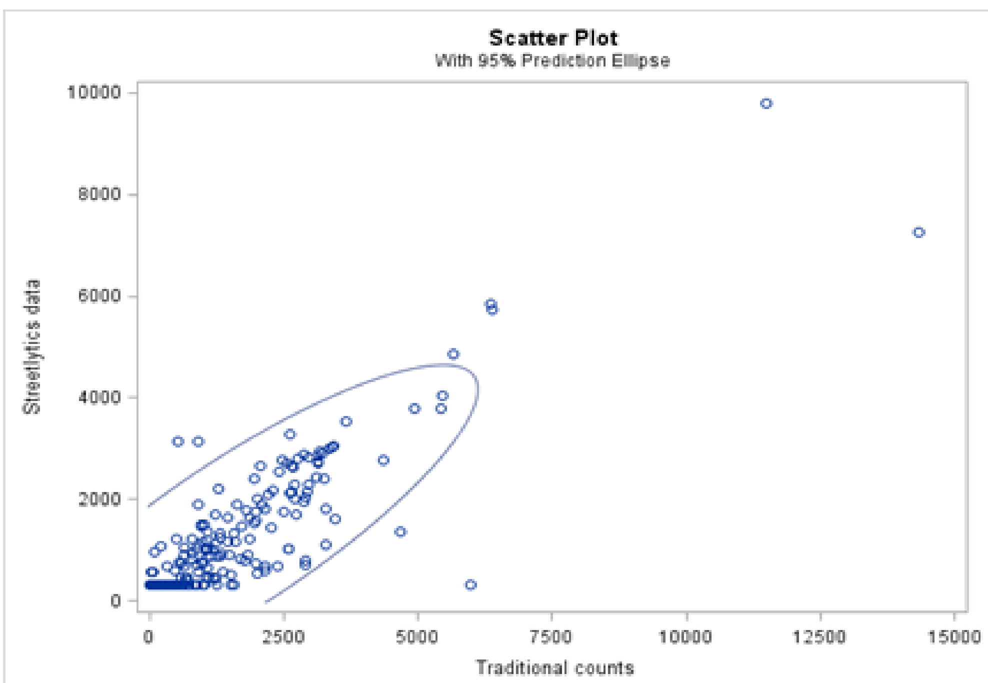

Figure 24

Scatterplot of data from Unobserved locations

Table 6
AADT ranges with percentage of data and average percentage difference (Observed locations)

AADT Range	Percentage of data	Average Percentage difference	Dataset with higher AADT values
>0	100%	23.60%	Traditional
>50	100%	23.60%	Traditional
>150	100%	23.60%	Traditional
>300	100%	23.60%	Traditional
>500	100%	23.60%	Traditional
>1000	100%	23.60%	Traditional
>1500	100%	23.60%	Traditional
>3000	100%	23.60%	Traditional
>5000	72%	22.61%	Traditional
>7000	46%	22.39%	Traditional
>10000	20%	21.57%	Traditional

Table 7
AADT ranges with percentage of data and average percentage difference (Unobserved locations)

AADT Range	Percentage of data	Average Percentage difference	Dataset with higher AADT values
>0	100%	53.9%	Traditional
>50	96%	48.58%	Traditional
>150	90%	43.90%	Traditional
>300	85%	43.83%	Traditional
>500	78%	44.54%	Traditional
>1000	58%	40.86%	Traditional
>1500	42%	40.26%	Traditional
>3000	14%	35.90%	Traditional
>5000	4%	45.28%	Traditional
>7000	1%	40.64%	Traditional
>10000	1%	40.64%	Traditional

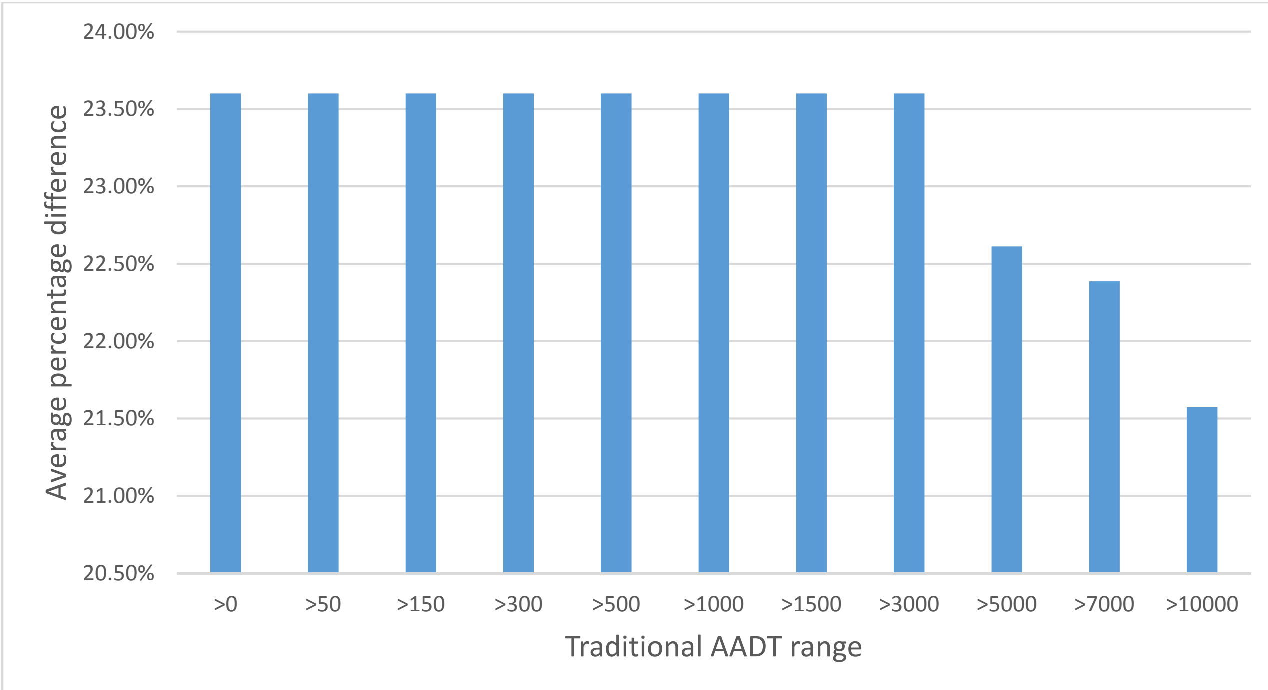

Figure 25
Distribution of percentage differences for Observed locations

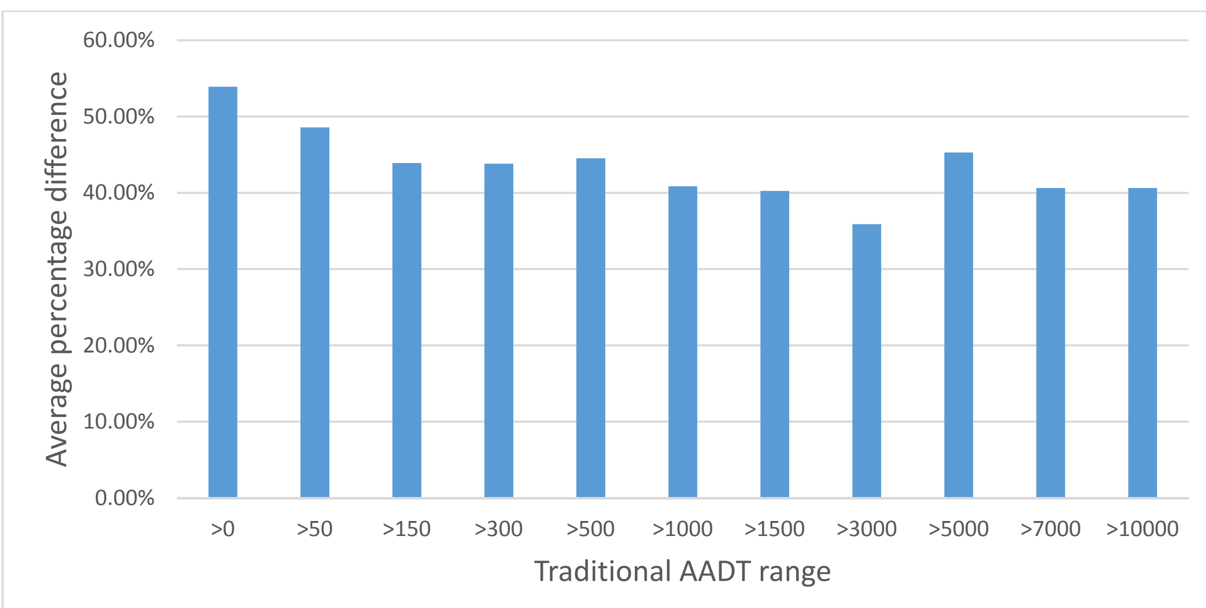

Figure 26
Distribution of percentage differences for Unobserved locations

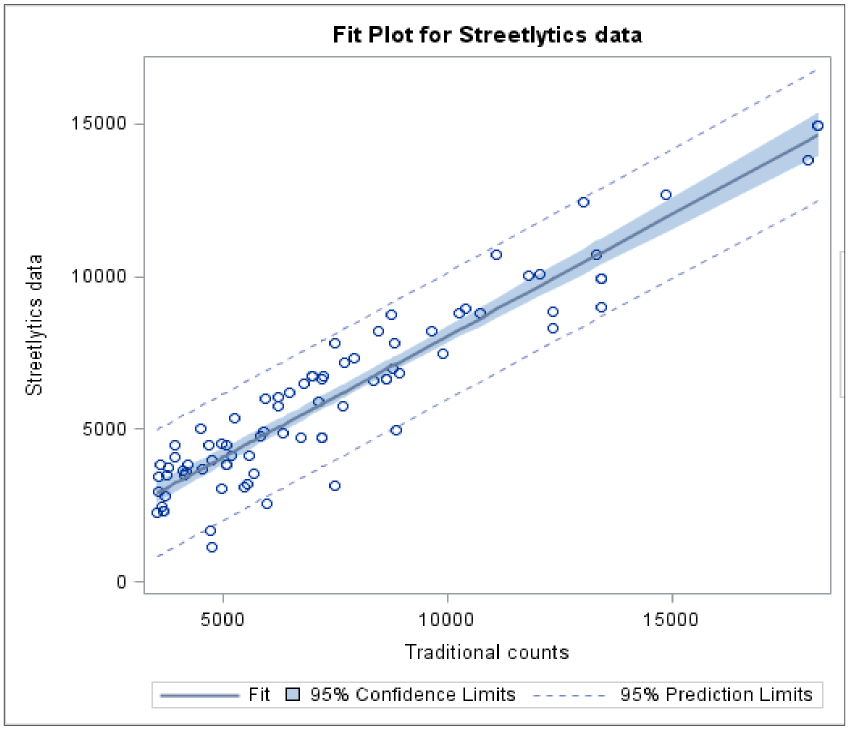

Figure 27
Regression results for Observed locations

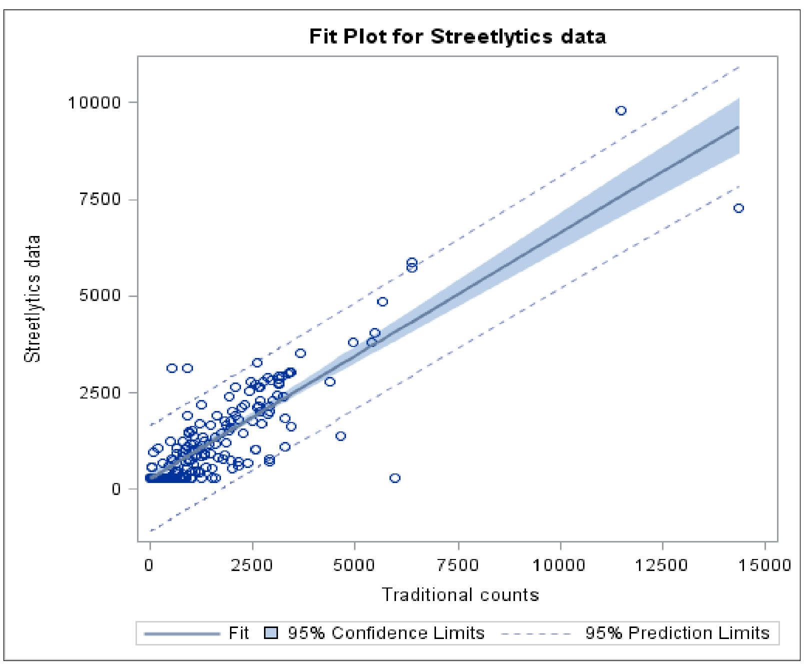

Figure 28
Regression results for Unobserved locations

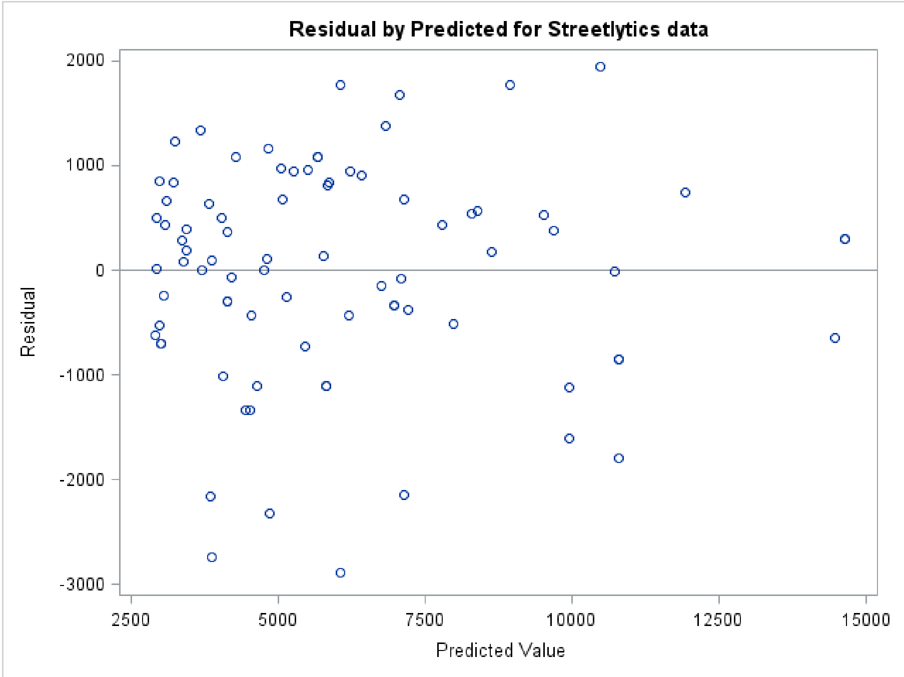

Figure 29
Residuals vs. Streetlytics data (observed locations)

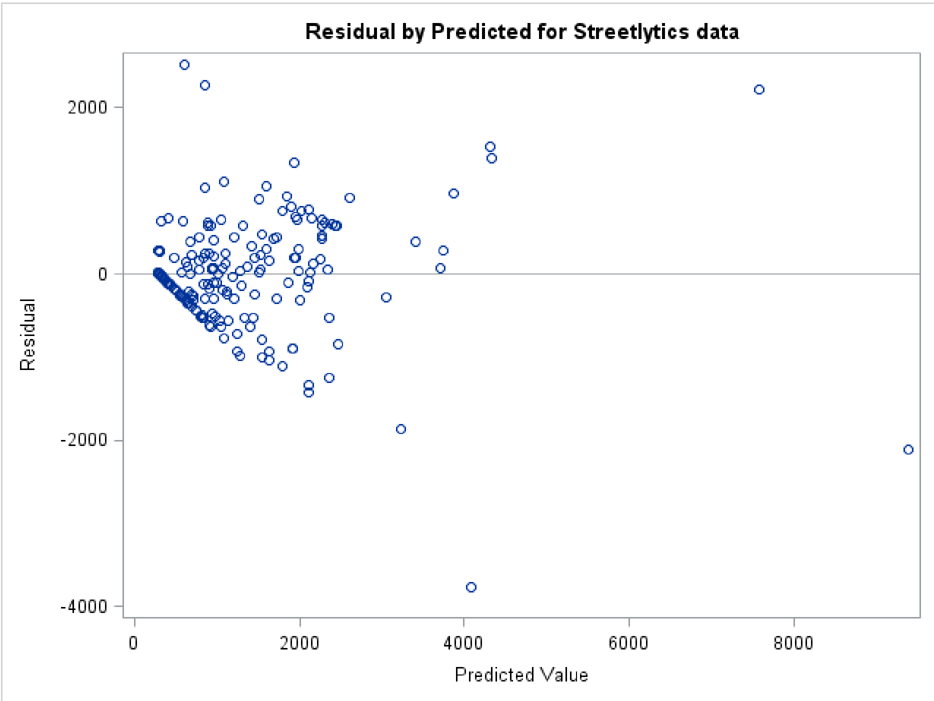

Figure 30
Residuals vs. Streetlytics data (Unobserved locations)

Table 8
Comparison of correlation, percentage difference, and regression statistics

		Sample size	Bivariate Correlation Coefficient	Average Percentage Difference	R-square (with p-value)
Level 1	All data	273	0.95	44.50%	0.90 (p<0.001)
Level 2	Routine counts	268	0.96	45.01%	0.92 (p<0.001)
	Permanent counts	5	*not computed due to sample size restrictions	43.00%	*not computed due to sample size restrictions
Level 3	Unobserved locations (routine counts)	185	0.85	53.90%	0.73 (p <0.001)
	Observed locations (routine counts)	83	0.94	23.60%	0.88 (p <0.001)
	Unobserved locations (Permanent counts)	5	*not computed due to sample size restrictions	43.00%	*not computed due to sample size restrictions

Comparative Cost Analysis

Cost of Streetlytics

Streetlytics is delivered to users as an annual subscription service and can be currently subscribed as an Online User Interface, an On-Premises Dataset, or both. The Online User Interface is a web application in which up to five users are simultaneously given access to volume maps, direction of primary flow, congestion levels, driver demographics, trip purpose, trip patterns, and Esri tapestry segmentation. Trip patterns consist of visualization of origins-destinations at a census-block group level. However, data is not downloadable with the Online User Interface platform. Figures 3 to 8 show screenshots of some of the features a user can access with this platform. The Select Link Analysis feature of Streetlytics can also only be accessed through the Online User Interface platform. This feature allows users to select a particular roadway or location and observe origins-destinations of travelers passing through. The On-Premises Dataset is delivered as a Geodatabase (GDB) format and allows users to analyze the data via any GIS software such as ArcGIS. Figure 10 shows an example screenshot within the Baton Rouge Metropolitan Area GDB opened in ArcGIS. Only traffic volumes are delivered with the On-Premises Dataset platform, with demographics, Esri tapestry segmentation, and speed delivered as add-ons. Speed data consists of average vehicle speeds on each roadway at hourly intervals, i.e., 1 pm to 2 pm, 2 pm to 3 pm, etc. Unlike the Online User Interface platform, all data within the On-Premises Dataset is downloadable and can be analyzed with the user's own tools.

Furthermore, each of the two platforms can be subscribed as Static data or Monthly data. The Static data option gives a single data reading for a typical day of the year for a selected roadway. This reading will not change for the chosen year. For instance, it may give the user a traffic volume that represents an AM peak value for a typical Monday for the year 2015. On the other hand, the Monthly data platform provides data which takes into account seasonal variations. This option gives a traffic volume that will represent an AM peak value for a typical Monday in February for the year 2015. The two types of data will therefore provide different readings for speed, Esri tapestry segmentation, demographics, and traffic volumes. It is worth noting that for traffic volumes, while average daily readings differ, the AADT values will not be affected and will remain the same. Table 9 provides a summary of the annual subscription costs for the city of Baton Rouge alone, and for the state of Louisiana.

Table 9
Annual Subscription Fees for Streetlytics

	Baton Rouge		**Louisiana**	
	Static data (Typical Day)	Monthly data (Seasonal Variations)	Static data (Typical Day)	Monthly data (Seasonal Variations)
On-Premises Dataset				
Traffic Volumes	$ 50,000	$ 90,000	$ 120,000	$ 195,000
Demographics	$ 10,000	$ 18,000	$ 24,000	$ 40,500
Segmentation	$ 10,000	$ 18,000	$ 24,000	$ 40,500
Speed	$ 10,000	$ 18,000	$ 24,000	$ 40,500
Online User Interface				
Traffic Volumes, Trip Patterns, Demographics, Segmentation	$ 30,000	$ 70,000	$ 77,500	$ 155,000
Select Link Analysis	$ 15,000	$ 35,000	$ 30,000	$ 70,000

Cost of Traditional Count Data

The Traffic Monitoring Unit at DOTD collects the Traditional count data for all of the state roadways therefore there are no actual costs associated with these collections since in-house field crews are used for labor. However, the goal of this exercise is to calculate the cost DOTD will incur to replicate its data collection efforts across the entire state for locations without traffic counts and compare with the cost of Streetlytics. It is anticipated that this exercise will provide some insights on the potential savings to be realized in using Streetlytics to provide AADT for roadways not maintained by DOTD. For simplicity, only costs to obtain 48-hour short duration counts are used for the cost estimation. Costs for setting up and collecting additional data from Permanent stations (necessary to generate seasonal factors) are ignored. Also, costs to analyze the 48-hour counts for generation of AADTs have been ignored. The cost generated, therefore, is a very low estimate that is to be treated as a minimum cost estimate and is only used for comparison to the Streetlytics annual subscription fee.

The state of Louisiana contains approximately 61,300 miles of public roads of which DOTD is the owner-operator of about 16,643 miles of state roadways. This mileage is in roadway miles and does not include bridges, gravel roads, brick roads, or roads without pavement ratings. Based on the 2015 Transportation Plan provided by DOTD, the state roadways are grouped into four classes: Interstate Highway System (IHS), Non-Interstate National Highway System (NHS), Statewide Highway System (SHS), and Regional Highway System (RHS) *[23]*. The IHS comprises entirely rural and urban interstates, which are designed to provide the highest level of speed and capacity for non-local travel. The NHS includes all other non-interstate roadways, such as some urban and rural arterial highways and a few urban and rural collector highways. The SHS complements the NHS and comprises those highways not on the NHS with a principal function of moving people and goods across and between cities and regions. The RHS provides access and mobility for local travel within cities and regions *[23]*. Table 10 shows a breakdown of how the total mileage maintained by DOTD in Louisiana is categorized under these four categories.

Table 10
State roadways stratification by mileage

DOTD Maintained State Highway Categories	MILEAGE	Percent
Interstate Highway System (IHS)	926	5.56%
Non-Interstate Highway System (NHS)	2,072	12.45%
Statewide Highway System (SHS)	6,203	37.27%
Regional Highway System (RHS)	7,442	44.72%
Total Mileage Maintained by DOTD:	16,643	100.00%

DOTD's Routine traffic count cycle is implemented yearly for one-third of the state, across the 16,643 miles maintained, and at approximately 4,200 sites over a period of three years. The amount of mileage not maintained by DOTD in regards to AADT estimation amounts to approximately 44,657 miles. All IHS and NHS roadways are included in the 16,643 miles maintained by DOTD. The ratio of mileage maintained by DOTD to the sites maintained by DOTD during a Routine traffic count cycle, is calculated by dividing 16,643 miles by 4,200 sites and equals to about 4 miles per site. Assuming a similar effort, the potential amount of sites needed for roadways not maintained by DOTD is 44,657 miles divided by 4 miles per site, which approximates 11,200 sites and includes all SHS and RHS roadways.

The research team obtained costs for 48-hour counts, stratified by roadway type, from the Traffic Monitoring Unit *[24]*. Table 11 presents these costs for the various roadway categories.

Table 11
Estimated cost of 48-hr. volume counts for state roadways

State-Highway Categories	Cost of 48-Hour Volume Counts
Interstate Highway System (IHS)	
Interstate 4-Lane	$110.00
Interstate 6-Lane	$165.00
Non-Interstate Highway System (NHS)	
Non-Interstate (2-Lane)	$55.00
Non-Interstate (More than 2-Lane)	$75.00
Statewide Highway System (SHS)	$38.50
Regional Highway System (RHS)	$38.50

Since DOTD maintains all roadways including the IHS and SHS, this analysis will only need to account for SHS and RHS roadways. An average of $38.50 per 48-hr count for the additional 11,200 sites (across 44,657 miles of statewide and regional roadways) is calculated and the total cost associated with covering these sites is $38.50 * 11,200 = $431,200.

Benefits of Streetlytics

The objective of Streetlytics is to provide supplemental traffic volumes for the state of Louisiana, especially for locations with no traditional traffic count data. The analysis in the previous section shows that it will cost a minimum of $431,200 to generate traditional AADTs for locations with no traffic count data. On the other hand, Streetlytics provides an annual typical day (static) data for all these locations (and more) at a cost of $120,000.

Another benefit is the number of count sites per roadway mileage. With DOTD maintained 16,643 miles of roadways statewide, and a statewide number of count sites at approximately 4,200, the ratio of mileage to count sites for Traditional count data stands at approximately 4:1. This can be interpreted as having an AADT count for every 4 miles (21,120 ft.) of roadway that is maintained by DOTD. On the other hand, the mileage covered and the number of AADT points in the Streetlytics data for the Greater Baton Rouge Metropolitan Area are 17,325 miles and 113,762 respectively. This produces a mileage: count stations ratio of 0.15:1 and can be interpreted as having an AADT count for every 0.15 miles (or 800 ft.) of all roadways. The main benefit is having so many AADT counts for roadways that would otherwise have no Traditional count data available.

Besides the benefits aforementioned, Streetlytics provides a complete picture of an entire population's movements within and through a region by providing for every roadway link, traffic volumes, primary direction of flow, patterns of traffic congestion, demographics of drivers, trip purposes, and origin-destination patterns. It therefore has a potential to benefit retailers, developers, outdoor advertisers, insurance companies, real estate agencies, and transportation agencies. Having knowledge of the number of vehicles, and the demographics of the driver, passing near a specific location will equip retailers, developers and outdoor advertisers with data to make the smartest choices for advertising products, and in identifying hot spots for commercial development, leasing, and the selection of new locations (for housing, stores, or other developments). For insurance companies, combining traffic volume and congestion levels with demographic factors can elaborate on which roadways will have higher-risk drivers or elevated risk of experiencing crash-related events. Potential homeowners and real-estate agencies can also benefit from in-depth knowledge of the demographics and patterns of travels on neighboring roadways as well as the level of traffic plying the neighborhood. For transportation agencies, Streetlytics provides a tool to analyze traffic volumes, congestion patterns, origin-destination patterns etc. to actively inform public works, planning, and economic development decisions. With such insights, state agencies can optimize budgets for specific roadways, avoid unexpected travel delays through feedback to the traveling public, and accurately understand the consequences of proposed development and improvements.

CONCLUSIONS

The primary objective of this study was to evaluate the accuracy of Streetlytics count data and to make a recommendation as to whether the state of Louisiana can adopt this tool to provide accurate AADTs for all its roadways. To achieve this, a list of roadways, both state and non-state, within the Baton Rouge Metropolitan Area (BRMA) for which there are available traditional traffic counts were developed. Afterwards, a suitable sample size was developed based on statistical methods. Based on the sample size obtained from computation, a comparative analysis of the Streetlytics and Traditional count data was undertaken, to determine how comparable they are.

The data was analyzed on three levels to compare Traditional count data to Streetlytics count data. Level 1 comprised all data, level 2 comprised Routine count data versus Permanent count data, and level 3 comprised Observed locations versus Unobserved locations. Streetlytics count data refers to AADTs obtained from the Streetlytics tool while Traditional count data refers to either Routine count data or Permanent count data. Routine count data are AADTs estimated from 48-hour short duration counts while Permanent count data are AADTs obtained from Permanent count stations. Observed locations refer to areas for which there were publicly available traditional counts that were used as part of the data sources to generate the Streetlytics count data, otherwise these areas are referred to as Unobserved locations.

For all three levels, a strong positive bivariate correlation coefficient was obtained, with values ranging from 0.85 for Routine count data (Unobserved locations) to 0.96 for all Routine count data (both at Observed and Unobserved locations). Estimates for Permanent count data were not produced because of limited sample size. The strong positive correlation means that for roadways with increasing Traditional count data, the Streetlytics counts also increases; and conversely, as one decreases, the other decreases. This highlights the potential for Streetlytics to provide counts which are comparable to the Traditional count data for all roadways and for all AADT ranges. This is particularly useful in Unobserved locations where there is a lack of traditional count data.

The percentage differences between the two datasets (Streetlytics and Traditional count data), however, ranged from 23.60% to 53.90% for all three levels. The percentage difference was lowest at 23.60% for Routine count data comparisons at Observed Locations, comparing similarly to an FHWA study that reported differences of 22% to 25% for comparisons between AADTs generated from 48-hour durations (Routine count data) versus AADTs obtained from Permanent stations. The highest percentage differences were expectedly obtained at Unobserved locations at 53.90% for Routine count data and 43.00% for Permanent count data. The research team were able to attribute these high differences to the fact that Streetlytics count data has a minimum AADT value fixed at 300 vpd. Louisiana has a lot of roadways with lower AADT values and for the data analyzed, 10% of all the data had AADT under 300 vpd. Most of these roadways will be in rural locations because of the low AADT values (under 300). The data analysis showed 110.38% and 37.08% percentage differences between the two datasets for AADT<300 vpd and AADT≥300 vpd respectively. These values reveal how capping the AADT at 300 vpd negatively skews the percentage differences estimated for Unobserved locations, many of which will be at rural locations. It can therefore be inferred that Streetlytics counts at Unobserved locations can be made more comparable to Traditional AADT counts at locations with low AADTs by lowering the minimum AADT that is currently set to 300 vpd. A recommendation of 50 vpd has been made since only 3% of all the data analyzed had AADT values below 50 vpd.

Differences exist between the means of Streetlytics count data when compared to the Traditional count data, with the former estimating lower AADTs than the latter. These difference margins were also greater with lower AADT values. However, the strong positive bivariate correlations obtained, and the high positive regression coefficients (0.73 to 0.92) associated with the data sets suggest that the Streetlytics count data are highly comparable to the Traditional count data. It can be concluded that since Streetlytics combines with plethora of data sources, it is a good source of data to supplement Traditional Data. More so, on-premises data offers more flexibility to work with since it is delivered as Geo-database or generic shapefile format for use in GIS platforms or Map Services to give researchers and practitioners the ability to access and review historic data over time. However, DOTD will have to review next steps in how to fully integrate this dataset into their existing data usage and reporting systems.

For this study, Streetlytics was evaluated for the purpose of providing supplemental traffic volumes (AADT) to the state. Being able to provide DOTD with AADT counts on virtually all road networks in Louisiana will give a better understanding of how Louisiana's roads are actually being used. AADT counts are not only required by law but AADT estimation itself facilitates the process for determining and prioritizing funds for various road safety and improvement projects. Streetlytics will readily provide AADT for Unobserved roadways and will help reduce the cost and time constraints of otherwise contracting out a survey to be undertaken for an Unobserved roadway. Considering that DOTD's Traffic Monitoring Unit collects data on approximately 16,643 miles of Louisiana's 61,300 miles of public roadway, Streelytics will provide data for the remaining 44,657 miles at a fraction of what would have normally cost to traditionally collect.

One limitation for this study is that researchers found it very challenging to obtain traditional count data for the year 2015 for comparison to the 2015 data provided by Streetlytics. The sample was therefore made up of only roadways for which the researchers were able to obtain traditional AADT data for 2015. This reduced the sampling frame and consequently, the randomness of the sample considerably. However, it did not affect the sample size as the number of data points obtained were well within the sample size.

RECOMMENDATIONS

DOTD personnel need traffic counts for their routine job demands, specifically for road safety assessments, crash data assessments, traffic operations, roadway planning and roadway design. However, due to budget constraints, traditional traffic counts are available for a limited number of roadways. Streetlytics fills in the gap by providing traffic counts for every roadway link in the state. While counts from Streetlytics have been estimated, they are the end result of complex interactions between billions of Observed data points using cell phone carrier data, GPS device data, cell phone apps GPS data, and both publicly available and privately sourced traffic counts. Furthermore, this study shows that the Streetlytics data is comparable to available traditional traffic counts. The study therefore recommends a statewide adoption of the Streetlytics data.

A survey of DOTD personnel yielded very low responses but an outfit expressed interest in the following traffic volumes in addition to AADT: AM peak, PM peak, mid-day volumes, off-peak volumes, and daily volumes. For this reason, the study recommends subscribing to the Monthly data which takes into account seasonal variations and provides typical volumes for a day in a month of a given year.

DOTD is currently considering obtaining probe speed data along with analytical tools for its network of National Highway System (NHS). Being able to analyze a combination of traffic volumes and speed data will provide more insights to the assessments undertaken with the analytical tools e.g. user delay costs due to congestion, and a number of MAP-21 performance indices. Streetlytics data therefore need to be in a downloadable state to be exported and utilized with the probe data analytical tools. For this reason, the study recommends subscribing to the On-Premises Dataset.

Annual subscription of the On-Premises Dataset (Monthly data) Traffic Volumes for the State of Louisiana amounts to $195,000. This amount does not include cost for demographics, Esri tapestry segmentation, and speed data. For the purpose of providing just traffic volumes, there is no need to acquire these extra add-ons except speed data which DOTD is considering obtaining separately. Streetlytics data will not only be useful to DOTD’s nine districts, but also to Louisiana’s 10 Metropolitan Planning Organizations. The study recommends the completion of the following specific tasks prior to acquiring the annual subscription license:

- Identify business areas in need of the product.
- Identify the number of licenses needed.

- Negotiate user terms with vendor, since currently it allows for only five (5) simultaneous users.
- Negotiate with vendor to set minimum AADT value to 50 vpd (only 3% of data falls below 50 vpd) as opposed to the current 300 vpd (approximately 10% of data falls under 300 vpd).
- Identify funding sources.
- Identify next steps in how to fully integrate Streetlytics into DOTD's existing data usage and reporting systems

Since this study focused on only AADT, additional research can be done with other types of data provided by Streetlytics, for instance, origin-destination data and traffic congestion data especially for rural applications. Also, in order to address the limitation of having a fixed minimum AADT for all roads, percentage differences should be recalculated, especially for rural locations, when the min AADT is changed from the fixed value of 300 to a lower value (e.g. 50 vpd) to evaluate the comparability of data from the two sources of interest.

ACRONYMS, ABREVIATIONS, AND SYMBOLS

AADT	Annual Average Daily Traffic
B2B	Business-to-Business
CBSA	Core Based Statistical Areas
CSP	Communication Service Provider
DOT	Department of Transportation
DOTD	Department of Transportation and Development
FHWA	Federal Highway Administration
GIS	Geographical Information System
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
LSP	Lifestyle Segmentation Profile
MPO	Metropolitan Planning Organization
NHS	National Highway System
NVF	Network Functions Virtualization
OD	Origin-Destination
OTT	Over-The-Top Context
SDN	Software-Defined Networking
TAZ	Traffic Analysis Zone
TDaas	Telecommunication Data as a Service
VMT	Vehicle Miles Traveled
VPD	Vehicles per day
WiSE	Wireless Signal Extraction
XML	Extensible Markup Language

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APPENDIX A

Inventory of Roadways

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Total Mileage	**1672.22**	**342.54**	**711.47**	**126.35**	**363.74**	**128.12**
Roadway Mileage in CRMPO Urban Area	**1238.77**	**247.85**	**675.86**	**47.89**	**210.49**	**56.68**
Roadway Mileage in CRMPO Rural Area	**433.45**	**94.69**	**35.61**	**78.46**	**153.25**	**71.44**
	Urban Area					
Urban Interstate	**133.25**	**29.42**	**62.85**		**31.71**	**9.27**
I-10	66.4	29.42	27.71			9.27
I-110	17.64		17.64			
I-12	48.38		16.67		31.71	
N 10th Street	0.28		0.28			
S 10th Street	0.27		0.27			
W Highway Drive	0.28		0.28			
Urban Principal Arterial	**252.04**	**42.6**	**165.14**	**3.52**	**18.11**	**22.67**
Airline Highway	31.58	13.84	17.74			
Alexander Drive	0.98					0.98
Baker - Zachary Highway	2.55		2.55			
Baker Road	2.82		2.82			
Bluebonnet Boulevard	5.15		5.15			
Burbank Drive	7.59		7.59			
Burnside Avenue	2.44	2.44				
Chippewa Avenue	1.66		1.66			
Church Street	2.11		2.11			
College Drive	1.56		1.56			
Corporate Boulevard	1.64		1.64			
Coursey Boulevard	1.32		1.32			
Essen Lane	1.85		1.85			
Florida Avenue	2.57				2.57	
Florida Boulevard	17.03		17.03			
Government Street	3.55		3.55			
Greenwell Springs Road	10.51		10.51			
Highland Road	5.04		5.04			
Hummel Street	0.33				0.33	
Jefferson Highway	5.64		5.64			
LA 1	17.79	3.31		3.52		10.96
LA 16	8.13				8.13	
LA 19	5.12		5.12			
LA 22	2.37	2.37				
LA 3002	0.33				0.33	
LA 3089	3.71	3.71				
LA 415	0.51					0.51
LA 42	3.36	3.36				
LA 44	6.95	6.95				
LA 70	2.59	2.59				
Lee Drive	2.04		2.04			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Lobdell Hwy	3.55					3.55
Magnolia Beach Rd	1.14				1.14	
Magnolia Bridge Road	1.06		0.44		0.62	
Main Street	3.02		3.02			
Mt Pleasant - Zachary Road	3.31		3.31			
N 22nd Street	0.96		0.96			
N Foster Drive	0.78		0.78			
N Range Avenue	3.21				3.21	
N. Alexander Ave	0.77					0.77
Nicholson Drive	6.53	4.03	2.5			
Old Hammond Highway	7.35		7.35			
Perkins Road	8.61		8.61			
Plank Road	13.5		13.5			
River Road	1.75		1.75			
S 22nd Street	0.27		0.27			
S Alexander Avenue	0.52					0.52
S Foster Drive	1.18		1.18			
S Range Avenue	1.78				1.78	
Saint Louis Street	0.25		0.25			
Samuels Road	7.81		7.81			
Scenic Highway	3.48		3.48			
Sherwood Forest Boulevard	6.77		6.77			
Siegen Lane	3.81		3.81			
US 190	2.64		1.19			1.45
US 190 & LA 1	3.93					3.93
US 61	1.23		1.23			
Zachary - Deerford Road	2.01		2.01			
Urban Minor Arterial	**304.51**	**46.28**	**186.01**	**9.24**	**60.59**	**2.39**
4-H Club Road	1.14				1.14	
Acadian Thruway	6.17		6.17			
Arnold Road	6.32				6.32	
Baker Boulevard	1.03		1.03			
Baker Road	0.82		0.82			
Bellevue Dr	1.82			1.82		
Bentley Drive	1.62		1.62			
Cedarcrest Avenue	1.5		1.5			
Choctaw Drive	3.84		3.84			
Cockerham Road	1.57				1.57	
College Drive	0.34		0.34			
Coursey Boulevard	2.17		2.17			
Court Street	2.39					2.39
Dalrymple Drive	1.05		1.05			
Drusilla Lane	1.03		1.03			
E Roosevelt Street	0.1		0.1			
E Worthey Road	0.99	0.99				
East Ascension Road	0.25	0.25				
East Boulevard	0.75		0.75			
Florida Avenue	12.67				12.67	
George O'Neal Road	0.46		0.46			
Greenwell Springs - Port Hudson Rd	6.73		6.73			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Greenwell Springs Road	4.97		4.97			
Greenwell Street	2.88		2.88			
Groom Road	4.73		4.73			
Harding Boulevard	2.35		2.35			
Hatchell Lane	1.19				1.19	
Highland Road	9.58		9.58			
Hollywood Street	2.15		2.15			
Hollywood-Greenwell Crossover	0.27		0.27			
Hooper Road	9.91		9.91			
Jefferson Highway	8.61	2.89	5.72			
Jones Creek Road	1.19		1.19			
Joor Road	11.03		11.03			
Juban Road	4.44				4.44	
Kenilworth Parkway	2.02		2.02			
LA 1	3.58	3.58				
LA 16	3.56				3.56	
LA 22	5.68	5.68				
LA 37	1.75		1.75			
LA 42	5.17	5			0.17	
LA 431	9.64	9.64				
LA 447	3.09				3.09	
LA 73	6.36	6.36				
LA 74	3.54	3.54				
Lavey Lane	2.53		2.53			
Lobdell Avenue	2.94		2.94			
Lockhart Road	1.89				1.89	
Lower Zachary Road	1.92		1.92			
LSU Avenue	0.48		0.48			
Magnolia Bridge Road	1.26		1.26			
Main Street	1.47		1.47			
Mickens Road	2.99		2.99			
Millerville Road	1.5		1.5			
Mohican - Prescott Crossover	0.46		0.46			
Mohican Street	1.07		1.07			
Monterey Boulevard	1.18		1.18			
Monterey Drive	0.94		0.94			
N Flannery Road	2.39		2.39			
N Foster Drive	3.15		3.15			
New Weis Road	0.77		0.77			
Nicholson Drive	21.38	6.71	7.25	7.42		
Nicholson Drive Extension	0.75		0.75			
North Ascension Road	0.11	0.11				
North Boulevard	3.06		3.06			
North Street	3.07		3.07			
Old Scenic Highway	5.42		5.42			
O'Neal Lane	4.2		4.2			
Park Boulevard	1.21		1.21			
Pecue Lane	2.58		2.58			
Penaver Street	0.13		0.13			
Perkins Road	2.21		2.21			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Pete's Highway	10.69				10.69	
Plank Road	4.46		4.46			
Prescott Road	3.32		3.32			
Pupera Road	1.01	1.01				
Roddy Road	0.21	0.21				
Rushing Road	1.72				1.72	
S 19th Street	0.27		0.27			
S Choctaw Drive	5.25		5.25			
S Choctaw Drive Extension	1.81		1.81			
S Flannery Road	1.89		1.89			
S Harrell's Ferry Road	3.05		3.05			
S Range Avenue	0.7				0.7	
S Sharp Road	1.62		1.62			
Saint Charles Street	0.31		0.31			
Saint Ferdinand Street	0.52		0.52			
Scenic Highway	4.48		4.48			
Silverleaf Avenue	1.34		1.34			
Stanford Avenue	1.22		1.22			
Staring Lane	1.99		1.99			
Sullivan Road	4.35		4.35			
Thomas H. Delpit Drive	1.08		1.08			
Thomas Road	3.92		3.92			
Tiger Bend Road	1		1			
Vincent Road	1.55				1.55	
Walker North Road	3.36				3.36	
Walker South Road	6.53				6.53	
Wax Road	1.33		1.33			
Weber City Road	0.31	0.31				
West Lee Drive	0.63		0.63			
Zachary - Deerford Road	1.08		1.08			
Urban Collector	**313.74**	**55.38**	**163.04**	**28.10**	**51.15**	**16.07**
39th Street	0.75		0.75			
4-H Club Road	3.92				3.92	
Antioch Road	1.47		1.47			
Arnold Lane	0.28		0.28			
Avenue G	0.37					0.37
Baker Avenue	2.2		2.2			
Barringer-Foreman Road	1.91		1.91			
Barrow St	0.24			0.24		
Bawell Street	0.86		0.86			
Bayou Narcisse Road	0.52	0.52				
Bayou Rd	2.04			2.04		
Bell Rose Road	0.19				0.19	
Ben Hur Road	0.8		0.8			
Blackwater Road	5.98		5.98			
Blount Road	3.28		3.28			
Bluebonnet Boulevard	2.51		2.51			
Bluff Road	5.71	5.71				
Boone Avenue	1.1		1.1			
Brightside Drive	2.14		2.14			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Broussard Street	1.52		1.52			
Burgess Avenue	2.89				2.89	
Cane Market Road	5.39				5.39	
Cante Road	4.27	4.27				
Capital Street	0.29				0.29	
Capitol Access Road	0.33		0.33			
Capitol Lake Drive	0.39		0.39			
Carey Road	1.81		1.81			
Carpenter Road	0.42		0.42			
Causey Road	2.77	2.77				
Centerville Street	1.07				1.07	
Chevelle Drive	0.79		0.79			
Clay Cut Road	1.36		1.36			
Comite Drive	1.18		1.18			
Commerce Street	0.45					0.45
Commercial Dr	1.01					1.01
Commercial Drive	0.08					0.08
Cora Drive	0.79		0.79			
Cornerview Road	1.29	1.29				
Country Club Drive	0.03		0.03			
Court St	0.71			0.71		
Court Street	0.16					0.16
Denham Road	3.01		3.01			
Duplantier Road	0.67				0.67	
E Airport Drive	0.53		0.53			
E Brookstown Drive	0.73		0.73			
E Lakeshore Drive	0.32		0.32			
E State St	0.33		0.33			
East Ascension Road	0.18	0.18				
East Ascension School Rd	1.01	1.01				
East Cornerview Road	0.71	0.71				
Eden Church Road	1.31				1.31	
Edgewood Drive	0.56				0.56	
Elliot Road	2.18		2.18			
Enterprise Blvd	1.2			1.2		
Ernest Wilson Dr	0.34					0.34
Ernest Wilson Road	1.06					1.06
Evangeline Street	2.69		2.69			
Evergreen Rd	2.69			2.69		
Fairfields Avenue	2.06		2.06			
Faye Avenue	0.57					0.57
Fernwood Dr	1.27		1.27			
Fontainebleau Drive	0.86		0.86			
Forest Delatte Road	1.82				1.82	
Foster Road	2.28		2.28			
Franklin Street	0.17					0.17
Gardere Lane	1.94		1.94			
Germany Road	2.01	2.01				
Glen Oaks Drive	1.65		1.65			
Goodwood Avenue	1.17		1.17			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Goodwood Boulevard	4.66		4.66			
Gourier Avenue	0.91		0.91			
Government Street	1.33		1.12		0.21	
GSRI Road	1.79		1.79			
Gus Young Avenue	1.02		1.02			
Harding Boulevard	0.49		0.49			
Harris Road	1.42				1.42	
Harry Drive	0.23		0.23			
Hasse St	1.92			1.92		
Heck Young Road	2.08		2.08			
Highpoint Boulevard	0.64				0.64	
Hoo Shoo Too Road	1.35		1.35			
Hyacinth Avenue	0.69		0.69			
Independence Boulevard	0.57		0.57			
Industriplex Boulevard	1.35		1.35			
Irma Avenue	0.5	0.5				
Jackson Street	0.29				0.29	
Jefferson Street	1.07		1.07			
Jones Creek Road	1.28		1.28			
Julia Street	0.35				0.35	
LA 1148	0.86			0.86		
LA 18	3.12	3.12				
LA 22	0.09	0.09				
LA 308	3.52	3.52				
LA 3115	0.78			0.78		
LA 3120	1	1				
LA 327	10.94		10.94			
LA 327-S	0.37		0.37			
LA 405	4.48			4.48		
LA 409	1.75		1.75			
LA 415	0.31					0.31
LA 447	3.46				3.46	
LA 621	2.55	2.55				
LA 63	6.85				6.85	
LA 74	6.86	3.48		3.38		
LA 75	2.83			2.83		
LA 77	2.13			2.13		
LA 931	3.04	3.04				
LA 943	0.1	0.1				
LA 945	2.31	2.31				
Lafiton Lane	0.56					0.56
Lamm Street	0.09				0.09	
Lanier Drive	2.47		2.47			
Little John Drive	0.48		0.48			
Lockhart Road	2.64				2.64	
Louisiana Ave	0.02					0.02
Lovett Road	3.37		3.37			
Magnolia Drive	0.08		0.08			
Maple Street	0.5				0.5	
Maribel Drive	0.7		0.7			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Maryland Avenue	0.7					0.7
McClelland Drive	0.88		0.88			
McHost Road	2.2		2.2			
McHugh Road	4.73		4.73			
Merit Evans Road	1.03	1.03				
Mollylea Drive	0.37		0.37			
Morning Glory Avenue	0.64		0.64			
Morvant Road	1.14		1.14			
N 19th Street	0.65		0.65			
N Airway Drive	0.58		0.58			
N Ardenwood Drive	1.97		1.97			
N Eugene Street	0.37		0.37			
N Foster Drive	0.17		0.17			
N Oak Hills Parkway	0.83		0.83			
N Stevendale Road	0.64		0.64			
N. 14th Street	0.99					0.99
N. Jefferson Ave	0.76					0.76
N. River Road	3.81					3.81
New Weis Road	0.41		0.41			
North Bryan Avenue	0.49	0.49				
North Edenborn Avenue	0.37	0.37				
North Marchand Avenue	0.49	0.49				
Oak Villa Boulevard	2.05		2.05			
Oaks Avenue	0.14					0.14
Old Baker - Zachary Road	2.38		2.38			
Old Scenic Highway	4		4			
Old Weis Road	0.47		0.47			
Orice Roth Road	0.99	0.99				
Pirie Drive	0.14				0.14	
Plantation Road	0.9				0.9	
Port Hudson - Pride Road	4.12		4.12			
Rafe Meyer Road	2.05		2.05			
Railroad Ave	1.07			1.07		
Raymond Avenue	0.06		0.06			
River Road	5.12		3.3		1.82	
Roddy Road	3.36	3.36				
Rodeo Drive	0.71				0.71	
Rollins Road	2.24		2.24			
Ronaldson Road	0.52		0.52			
Rosedale Road	4.13					4.13
Rosenwald Rd	1.06		1.06			
Rue Crozat	0.9		0.9			
Rue de LaPlace	0.35		0.35			
Rue de Tonti	0.14		0.14			
Rue Larouge	0.05		0.05			
S Ardenwood Drive	0.43		0.43			
S Eugene Street	1.37		1.37			
S Harrell's Ferry Road	1.89		1.89			
S Jefferson Avenue	0.44					0.44
S Stadium Road	0.99		0.99			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
S Stevendale Road	0.32		0.32			
Satsuma Road	2.09				2.09	
Scenic Highway	0.91		0.91			
Sinbad Street	0.79		0.79			
Skip Bertman Drive	0.56		0.56			
Sorrel Avenue	0.73		0.73			
South Boulevard	0.21		0.21			
Spanish Town Road	1.34		1.34			
Springfield Road	5.56				5.56	
Spur Lane	0.22		0.22			
St Louis Rd	1.44			1.44		
St Patrick St	0.59	0.59				
Sunshine Road	1.17		1.17			
Tara Boulevard	0.89		0.89			
Tate Road	0.52				0.52	
Tenant Rd	1.31			1.31		
Terrace Avenue	1.55		1.55			
Thibaut Dr	0.69	0.69				
Thunderbird Beach Road	3.04				3.04	
Tiger Bend Road	5.07		5.07			
Tom Dr	0.69		0.69			
Tom Drive	1.16		1.16			
Veterans Memorial Blvd	0.7		0.7			
Victoria Drive	0.59		0.59			
W Central Avenue	1.28		1.28			
W Highway Drive	0.39		0.39			
W Lake Shore Drive	0.35		0.35			
W Lakeshore Dr	1		1			
W Roosevelt Street	0.91		0.91			
W Worthey Road	0.99	0.99				
Warren Rd	1.02			1.02		
Wax Road	1.81				1.81	
Weber City Road	4.57	4.57				
West Cornerview Road	3.31	3.31				
West Main Road	0.32	0.32				
Westdale Drive	0.49		0.49			
Wimbush Drive	0.96		0.96			
Winbourne Avenue	3.19		3.19			
Wooddale Boulevard	1.93		1.93			
Urban Local	**235.23**	**74.17**	**98.82**	**7.03**	**48.93**	**6.28**
72nd Avenue	1.66		1.66			
Alligator Bayou Rd	1.02	1.02				
America Street	0.06		0.06			
Antioch Blvd	1.02		1.02			
Aydell Ln	0.56				0.56	
Babin Rd	0.3		0.3			
Bayou Narcisse Rd	0.05	0.05				
Bayou Narcisse Road	2.49	2.49				
Bayou Paul Ln	2.75			2.75		

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Beco Rd	1.02	1.02				
Ben Hur Road	2.08		2.08			
Benton Fredric Road	1.76	1.76				
Big Bend Ave	0.81		0.81			
Black Bayou Road	3.88	3.88				
Black Mud Rd	0.31				0.31	
Blackwater Road	2.23		2.23			
Bogan Walk	0.33		0.33			
Boudreaux Road	1.2	1.2				
Braud Road	2.01	2.01				
Brentwood Drive	0.82		0.82			
Brian Park Dr	0.41				0.41	
Brittany Road	2.64	2.64				
Brown Rd	0.81				0.81	
Buddy Ellis Rd	3.45				3.45	
Burgess Road	2.98				2.98	
C Braud Rd	0.7	0.7				
Cannon Rd	3.03	3.03				
Carney Road	1.46		1.46			
Centerway Blvd	0.1		0.1			
Charlton Road	2.06		2.06			
Church Point Road	2.72	2.72				
Citiplace Ct	0.18		0.18			
Citiplace Dr	0.15		0.15			
Clinton Allen Rd	1.79				1.79	
Cloverland Ave	0.83		0.83			
Comite Drive	1.75		1.75			
Commercial Dr	1.09					1.09
Confederate Ave	0.75		0.75			
Connells Village Ln	0.49		0.49			
Convention Street	2.1		2.1			
Coon Trap Road	1.72	1.72				
Corbin Avenue	1.56				1.56	
Core Lane	1.59		1.59			
Country Club Dr	0.27		0.27			
Daigle Rd	1.77	1.77				
Denham Rd	0.64	0.64				
Devall Road	2.12		2.12			
Duff Road	2.79				2.79	
Dunn Road	2.93				2.93	
Duplessis Rd	1.65	1.65				
Dyer Road	2.87		2.87			
E Airport Drive	0.18		0.18			
E Highway Dr	0.07		0.07			
E Washington Street	0.79		0.79			
Elm Grove Garden Dr	1.06		1.06			
Ernest Wilson Dr	0.28					0.28
Exchecquer Dr	0.77		0.77			
Fairchild St	1.15		1.15			
Feather Nest Ln	0.24		0.24			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Florida Blvd Frontage Rd	9.9		9.9			
Ford Street	1.41		1.41			
Foss Street	0.12		0.12			
Frenchtown Road	1.99		1.99			
Fuqua St	0.34		0.34			
Fuqua Street	0.2		0.2			
Gaylord Rd	1.24				1.24	
George O'Neal Road	0.49		0.49			
George Rouyea Rd	2.03	2.03				
Gibbens Road	1.02		1.02			
Gold Place Rd	1.07	1.07				
Great Smokey Ave	0.87		0.87			
Gurney Road	1.93		1.93			
Hagerstown Dr	1.15		1.15			
Hanks Dr	1.13		1.13			
Harry Drive	0.89		0.89			
Hartman Rd	0.41				0.41	
Henderson Bayou Rd	1.55	1.55				
Hickory Ridge Blvd	1.26		1.26			
Hillon Hood Rd	1.44				1.44	
Hodges Lane	0.86				0.86	
Hodgeson Road	3.02	3.02				
Hoo Shoo Too Road	0.32		0.32			
Hornsby Road	1.63	1.63				
Hubbs Road	2.04		2.04			
Hundred Oaks Avenue	0.57		0.57			
Hunstock Road	0.68				0.68	
Hyacinth Avenue	0.92		0.92			
Indian Run Road	0.68		0.68			
Irene Road	0.76		0.76			
John L Ln	1.34				1.34	
K C Rd	1.02	1.02				
L Landry Rd	1	1				
LA 1022	1.83				1.83	
LA 1023	2.94				2.94	
LA 931	2.26	2.26				
LA 933	4.52	4.52				
LA 935	2.26	2.26				
LA 936	3.74	3.74				
Lafiton Lane	2.36					2.36
Laurel Street	1.27		1.27			
Linder Road	2.1				2.1	
Lockhart Ln	0.95				0.95	
Main Street	0.66		0.66			
Manchac Rd	4.28			4.28		
Mc Calop St	0.44		0.44			
McClelland Drive	0.36		0.36			
McCullough Road	1.9		1.9			
McLin Rd	3.18				3.18	
Millbrook Dr	0.64		0.64			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Milton Road	1.71				1.71	
Monitor Avenue	0.92		0.92			
Moody Dixon Rd	1.69	1.69				
Morgan Road	0.49		0.49			
N 10th Street	0.51		0.51			
N 19th Street	0.17		0.17			
N 21st Street	0.53		0.53			
N 28th St	0.94		0.94			
N 39th St	0.58		0.58			
N 44th St	0.58		0.58			
N 9th Street	0.51		0.51			
N Beck St	0.22		0.22			
N Coolidge Ave	0.5	0.5				
N Harrells Ferry Rd	0.51		0.51			
N Highway Dr	0.12		0.12			
New River Road	0.92	0.92				
Newcastle Ave	1.17		1.17			
North Marchand Avenue	0.03	0.03				
Norwood Rd	2.09	2.09				
Old River Road	1.79				1.79	
Orice Roth Road	0.79	0.79				
Parker Rd	1.79	1.79				
Pasadena Dr	0.74		0.74			
Pecue Lane	0.62		0.62			
Pendarvis Ln	2.08				2.08	
Perkins Rd	3.89				3.89	
Perkins Road	3.62	2.34	1.28			
Petit Road	2.4		2.4			
Philippi Road	0.5	0.5				
Picardy Ave	1		1			
Planchet Road	0.31		0.31			
Plank Road	0.17		0.17			
Pleasant Ridge Dr	0.66				0.66	
Port Hudson-Plains Rd	3.74		3.74			
Reiger Rd	1.11		1.11			
Renoir Avenue	0.75		0.75			
River Road	1.5		0.31		1.19	
River Run Estate Dr	1.75	1.75				
Roddy Road	3.82	3.82				
Rosenwald Rd	0.37		0.37			
S 10th Street	0.29		0.29			
S Highway Dr	0.12		0.12			
S Lanoux Avenue	0.49	0.49				
S Westport Dr	2.55					2.55
Saint Louis Street	0.27		0.27			
Sharp Lane	0.54		0.54			
Sherwood Commons Blvd	0.56		0.56			
Sims Rd	2.9				2.9	
South Boulevard	0.37		0.37			
South St	0.28		0.28			

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Stumberg Lane	1.14		1.14			
Terrace Avenue	0.11		0.11			
Thibodeaux Road	1.37		1.37			
Tiggy Duplessis Rd	1.03	1.03				
Tommy Moore Rd	0.6	0.6				
Tucker Road	5.89		5.89			
Valley St	0.67		0.67			
Vera McGowan	0.15				0.15	
Veterans Memorial Blvd	1.03		1.03			
W Worthey Road	1	1				
West Main Road	1.41	1.41				
William Ficklin Rd	1.02	1.02				
Woodlake Drive	0.69		0.69			
Woodland Ridge Blvd	1.89		1.89			
Rural Area						
Rural Interstate	**35.43**	**15.58**			**14.76**	**5.09**
I-10	20.67	15.58				5.09
I-12	14.76				14.76	
Rural Principal Arterial	**36.81**	**14.18**		**13.11**		**9.52**
LA 1	16.3	3.19		13.11		
LA 70	10.99	10.99				
US 190	9.52					9.52
Rural Minor Arterial	**27.45**	**7.87**			**19.58**	
Airline Highway	3.45	3.45				
Florida Avenue	8.58				8.58	
LA 16	10.11				10.11	
LA 22	2.85	1.96			0.89	
LA 3127	0.44	0.44				
LA 70	0.32	0.32				
US 61	1.7	1.7				
Rural Minor Collector	**125.61**	**32.81**	**6.81**	**47.61**	**30.33**	**8.05**
4-H Club Road	5.32			0.0	5.32	
Bayou Paul Lane	1.44			1.4		
LA 1019	4.22			0.0	4.22	
LA 1024	2.6			0.0	2.6	
LA 1148	2.54			2.5		
LA 141	1.73			1.7		
LA 22	7.43	7.43		0.0		
LA 3066	8			8.0		
LA 3066 Spur	0.1			0.1		
LA 3115	1.71			1.7		
LA 327	2.6			2.6		
LA 405	24.88	8.65		16.2		
LA 409	6.81		6.81	0.0		

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
LA 415	8.05			0.0		8.05
LA 44	1.32	1.32		0.0		
LA 444	5.15			0.0	5.15	
LA 449	8.56			0.0	8.56	
LA 63	4.48			0.0	4.48	
LA 69	0.1			0.1		
LA 75	23.45	10.29		13.2		
LA 942	5.12	5.12		0.0		
				0.0		
				0.0		
Rural Major Collector	118.42	7.65	10.58	9.74	49.23	41.22
LA 22	3.41			0	3.41	
LA 3125	0.4	0.4		0		
LA 37	10.58		10.58	0		
LA 413	4.73			0		4.73
LA 415	4.88			0		4.88
LA 42	17.09			0	17.09	
LA 44	5.7	5.7		0		
LA 441	5.19			0	5.19	
LA 442	0.29			0	0.29	
LA 447	3.73			0	3.73	
LA 620	7.12			0		7.12
LA 63	16.29			0	16.29	
LA 69	2.09			2.09		
LA 73	1.55	1.55		0		
LA 75	2.51			2.51		
LA 77	5.14			5.14		
LA 983	7			0		7
LA 984	5.81			0		5.81
LA 985	1.21			0		1.21
LA 989-1	0.5			0		0.5
LA 989-2	1.97			0		1.97
LA-989-1	0.73			0		0.73
Rosedale Road	7.27			0		7.27
Stafford Rd	3.23			0	3.23	
				0		
Rural Local	89.73	16.60	18.22	8.00	39.35	7.56
1st St	1.76			0		1.76
Addis Ln	0.55			0		0.55
Anderson Road	2.78		2.78	0		
Black Mud Rd	2.54			0	2.54	
Brown Rd	1.61			0	1.61	
Calumet Rd	1.4			0		1.4
Choctaw Road	3.47			0		3.47
Edenborne Blvd	0.3	0.3		0		

Street Name and Function Class	CRMPO Jurisdictions					
	Total Miles	ASC	EBR	IBER	LIV	WBR
Glen Watts Ln	1.89			0	1.89	
Hodgeson Road	1.31	1.31		0		
Hood Road	6.16			0	6.16	
Jack Allen Rd	2.07			0	2.07	
Jackson Road	4.41		4.41	0		
Joe May Rd	3.34			0	3.34	
LA 1023	1.08			0	1.08	
LA 1024	6.18			0	6.18	
LA 1025	1.91			0	1.91	
LA 1033	1.39			0	1.39	
LA 141	1.28			1.28		
LA 3251	3.76	3.76		0		
LA 69	0.9			0.9		
LA 943	7.81	7.81		0		
LA 944	2.56	2.56		0		
LA 991	5.82			5.82		
Main St	0.38			0		0.38
Palmer Road	3.29			0	3.29	
Peairs Road	5.98		5.98	0		
Red Oak Rd	6			0	6	
Scivicque Rd	0.66			0	0.66	
Springhill Dr	1.23			0	1.23	
St Landry Rd	0.86	0.86		0		
Tucker Road	5.05		5.05	0		

APPENDIX B

Streetlytics Data Dictionary

FIELD NAME	DESCRIPTION
FUNC_CLASS	Road Functional Class 1-5
ST_NAME	Street Name
AMPKDIR	Maximum peak flow direction for two way road is AM peak period flow (1/0)
PMPKDIR	Maximum peak flow direction for two way road is PM peak period flow (1/0)
TOTDATAP	Total daily traffic
TOTAMTAP	Total AM peak period (3 hour) traffic
TOTPMTAP	Total PM peak period (3 hour) traffic
TOTOPTAP	Total Off Peak (18 hour rest of day) traffic
TOTDAFQ	Flow Quality index (0 to 1) for Daily Traffic
TOTAMFQ	Flow Quality index for AM peak period
TOTPMFQ	Flow Quality index for PM peak period
TOTOPFQ	Flow Quality index for Off peak period
PERDACMN	Percent of Daily Traffic that is commute traffic
PERDAEDN	Percent of Daily Traffic that is education related traffic

PERDALCN	Percent of Daily Traffic that is local traffic (both origin and destination inside model region)
SUMDAICN	Sum of income of Daily Traffic flow ($1k)
AVGDAICN	Average income of Daily Traffic flow
AVGDAHHN	Average household size for Daily Traffic flow
AVGDAAGN	Average age of head of household for Daily Traffic flow
TOTDAIC1N	Daily Traffic flow in household income class 1 ($0-$25k)
TOTDAIC2N	Daily Traffic flow in household income class 2 ($25k-$50k)
TOTDAIC3N	Daily Traffic flow in household income class 3 ($50k-$100k)
TOTDAIC4N	Daily Traffic flow in household income class 4 ($100k+)
TOTDAHH1N	Daily Traffic flow in house hold size class 1
TOTDAHH2N	Daily Traffic flow in house hold size class 2
TOTDAHH3N	Daily Traffic flow in house hold size class 3
TOTDAHH4N	Daily Traffic flow in house hold size class 4
TOTDAHH5N	Daily Traffic flow in house hold size class 5+
TOTDAAG1N	Daily Traffic flow in head of household age class 1 (15-24)
TOTDAAG2N	Daily Traffic flow in head of household age class 2 (25-44)

TOTDAAG3N	Daily Traffic flow in head of household age class 3 (45-64)
TOTDAAG4N	Daily Traffic flow in head of household age class 4 (65+)
DIR	Direction of traffic flow (N, S, NW, etc.)

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