STATISTICAL ANALYSIS OF LAW ENFORCEMENT SURVEILLANCE IMPACT ON SAMPLE CONSTRUCTION ZONES IN MISSISSIPPI (Part 1: DESCRIPTIVE)

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Abstract – It is estimated that every year over 1000 people are killed and over 40,000 people are injured nationwide in roadway construction zones. Construction zones have a higher number of crashes and therefore special measures are required to improve roadway safety conditions. Law enforcement surveillance is one of the special measurements taken by several departments of transportation throughout the United States to reduce the number of crashes in construction zones. However, there are a limited number of studies documenting the impact of law enforcement surveillance in construction zones in the nation. This paper focuses on the descriptive statistical analysis that was performed to measure the impact of law enforcement surveillance in sample construction zones in Mississippi. More specifically, this paper includes statistical analyzes of traffic trends, crash information as well as characteristics of the studied area such as: a-Annual Daily Traffic Growth; b- Traffic Volume Variance; c- Hourly Distribution of the Traffic Volume and Vehicle Classification; d-Volume Hourly Peaks; e-Number of Citations; and f-Number of Crashes. The analysis presented in this paper can also be used to support case studies for class discussion and therefore build bridges to make connections between real data and educational experiences that facilitate engineering education. The results presented in this paper reveal the importance of performing statistical analysis to calculate quantifiable objective measures to assess the impact of safety programs. Additionally, it emphasizes the importance of sharing real life data (obtained from applied research experiences) with students to facilitate meaningful learning experiences..

Keywords: Law Enforcement Surveillance, Construction Zone, Statistics, Impact

INTRODUCTION

Construction zone's fatalities are on the rise and are likely to continue climbing across the nation as departments of transportation continue repairing and upgrading the United States' aging roadways [Safe Roads 2003]. This is particularly compounded in Mississippi due an all time peek volume of construction zones as well as the 1987 four-lane highway program and TEA-21 [Young 2001]. Therefore, it is very important to implement programs such as the law enforcement surveillance that aim to improve the safety records of construction zones.

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Unfortunately, in many cases these programs are implemented without the proper collection, processing, archiving and analysis of the data to evaluate their impact on safety.

Several agencies contributed to the data collection including District 5 Office of the Mississippi Department of Transportation, Planning Division of the Mississippi Department of Transportation, Mississippi Highway Patrol, Ridgeland Police Department, and Traffic Engineering Division of Mississippi Department of Transportation. Upon receiving the data from the different agencies, the data was restructured and consolidated to server as the foundation for descriptive and inferential statistics which are presented in this paper.

Overview of Statistical Analysis

Statistic analysis pertains to collection, analysis, interpretation, and presentation of data as well as drawing valid conclusions and making reasonable decisions on the basis of such analysis [Wikipedia 2006]. In most research projects the statistical analysis involves three major steps, done in roughly this order: Cleaning and organizing the data for analysis (Data Preparation), Describing the data (Descriptive Statistics), Testing Hypotheses and Models (Inferential Statistics)

Data Preparation. It involves checking or logging the data in; checking the data for accuracy; entering the data into the computer; transforming the data; and developing and documenting a database structure that integrates the various measures.

Descriptive Statistics. They are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with graphical analysis, they form the basis of virtually every quantitative analysis of data. Descriptive statistics are used to present quantitative descriptions in a manageable form. They are used to simply large amounts of data in a sensible way. Descriptive statistics involves the examination across cases of one variable at a time. With descriptive statistics the researchers are simply describing what the data shows. The three major characteristics of a single variable are its distribution, central tendency and dispersion.

a. Distribution is a summary of the frequency on individual values for a variable. One of the most common ways to describe a single variable is with a frequency distribution. Graphical forms such as histograms or bar charts are effective tools for depicting frequency distributions. [Trochim 2006]

b. Central Tendency of a variable is the estimate of the "center" of a distribution of its values. The three major types of estimates of central tendency of a variable are its mean, median and mode. The mean is the variable's average value. The median is the score found at the exact middle of a set of variable values. The mode is the most frequently occurring value for the variable. [Trochim 2006]

c. Dispersion refers to the spread of the values of the variable around the central tendency. The two most common measures of dispersion of a variable are its range and standard deviation. The range is the highest value of the variable minus the lowest value. The standard deviation is more accurate reflection of dispersion by reducing the effect of outlier values of a variable. [Trochim 2006]

DESCRIPTIVE STATISTICAL ANALYSIS

The statistical analysis began by analyzing traffic trends and characteristics of the studied area. The Mississippi Department of Transportation, the Ridgeland Police Department and the Mississippi Highway Patrol provided to the research team a wealth of data to perform the analysis. The studied area is shown with a green star in all the figures below. The construction project was located on I-59 at the Old Agency road area. The red lines in all the figures below represent the main area that was affected with the construction project as well as the main limits of the traffic and crash data collection efforts. However, as anticipated additional data was collected beyond the main area of influence (between the red lines) of the construction due to the fact that limited number of collection stations were located in the main affected area. The analysis of the studied area has been organized as follows:

a- Annual Daily Traffic Growth
b- Traffic Volume Variance
c- Hourly Distribution of the Traffic Volume and Vehicle Classification
d- Volume Hourly Peaks
e- Number of Citations – Ridgeland Police Department and Mississippi Highway Patrol
f- Number of Crashes

a- Annual Average Daily Traffic Growth

In the last 12 years, the studied area experienced a constant grow in annual average daily traffic years. The "blue arrows" in Figure 1, show the locations of measurement stations (A46 and A54) north and south of the Old Agency work zone. As shown in Figure 1, the studied area has increased in annual average daily traffic approximately 3% to 4% per year from 1992 to 2004.

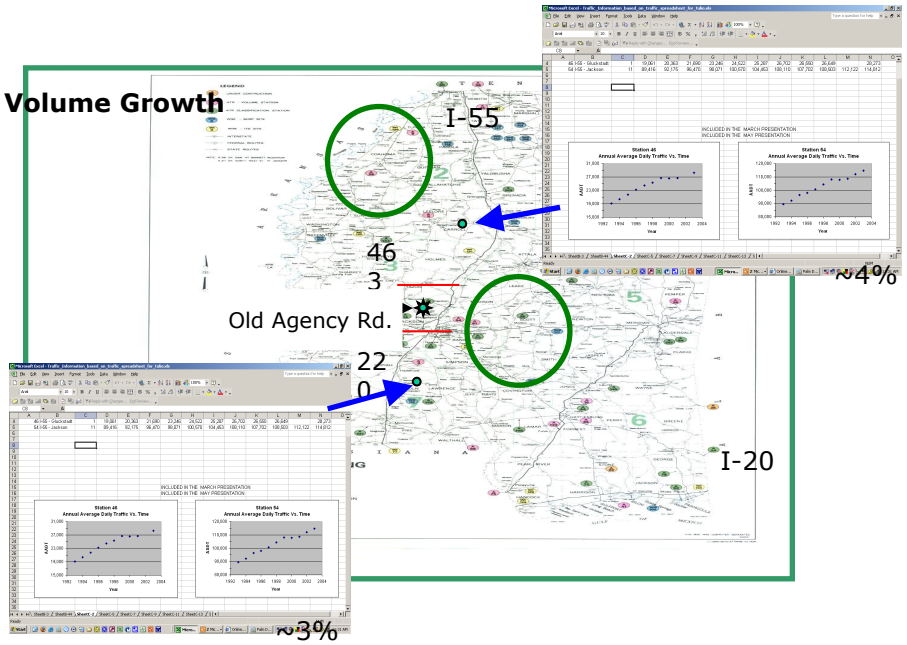

Figure 5-1. Traffic Volume Yearly Increase

b- Traffic Volume Variance

The trend of the traffic volume variance in the studied area is shown in Figure 2. Figure 2, shows the average daily traffic for each month in 2003 from Station 54, which is south of the Old Agency construction work zone. In top right portion of the figure, it can be observed that during the year there was no significant difference in the daily traffic ranging between 111,585 and 117,872 vehicles per day. The calculations resulted in a daily average traffic volume of 114,812 vehicles per day. In the top left portion of the same figure, it can be observed that the average weekday traffic is also very constant during the year with an average of 126,315 vehicles per day which is approximately 10% higher than the average daily traffic. However, both the Saturday and Sunday average of 92,843 and 72,197 vehicles per day respectively are significantly lower (-19% and -38% respectively) than the average daily traffic.

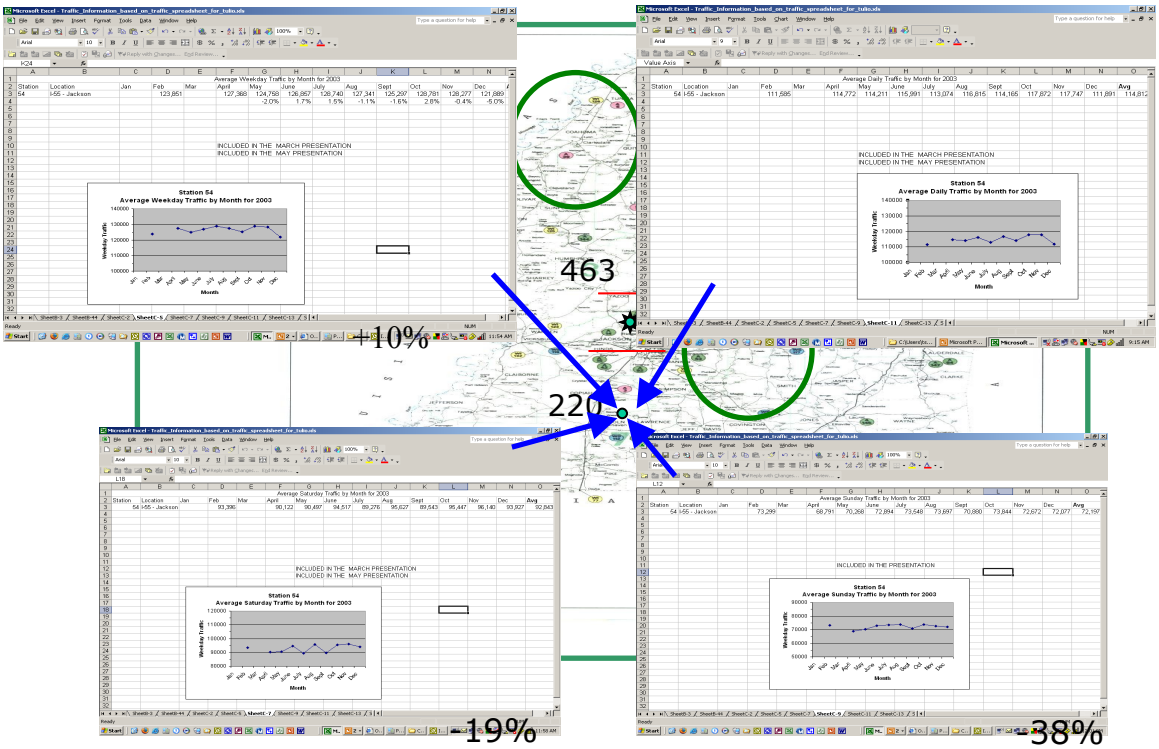

Figure 2. Traffic Volume Variance

c- Hourly Distribution of the Traffic Volume and Vehicle Classification

Most vehicle in the studied area were (according to FHWA Vehicle Classification) type 2 (Passenger Cars). Figures 3 through 6 shows a two days collection sample of the Traffic Volume by Vehicle Classification for north and sound bound in locations north and sound of the construction. The figures illustrate the traffic demand in the studied area. It worth noting that the traffic demand was at least 600 vehicles per hour per lane in non-rush hours with peek reaching up to 2500 vehicles per hour per lane.

Figure 3, shows the "Traffic Volume By Vehicle Classification" for north bound lanes 1, 2, and 3 south of the Old Agency construction work zone. Similarly, Figure 4 shows the "Traffic Volume By Vehicle Classification" for south bound lanes 1, 2, and 3 south of the Old Agency construction work zone.

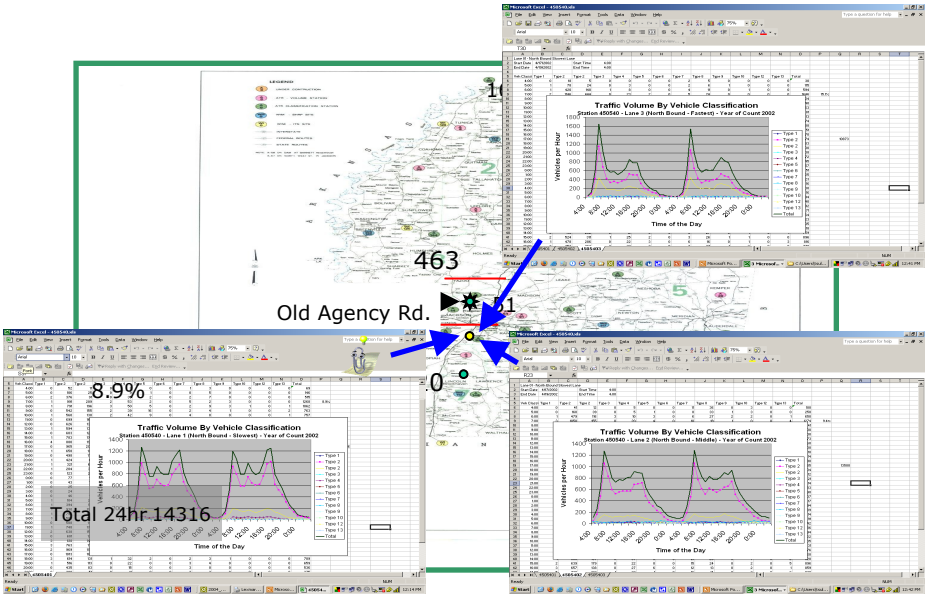

Figure 3. Traffic Volume Discriminated by Vehicle Classification
North Bound South of the Construction Zone

Figure 4. Traffic Volume Discriminated by Vehicle Classification
South Bound South of the Construction Zone

Figure 5, shows the "Traffic Volume By Vehicle Classification" for north bound lanes 1, and 2, north of the Old Agency construction work zone. Similarly, Figure 6 shows the "Traffic Volume By Vehicle Classification" for south bound lanes 1, and 2 north of the Old Agency construction work zone.

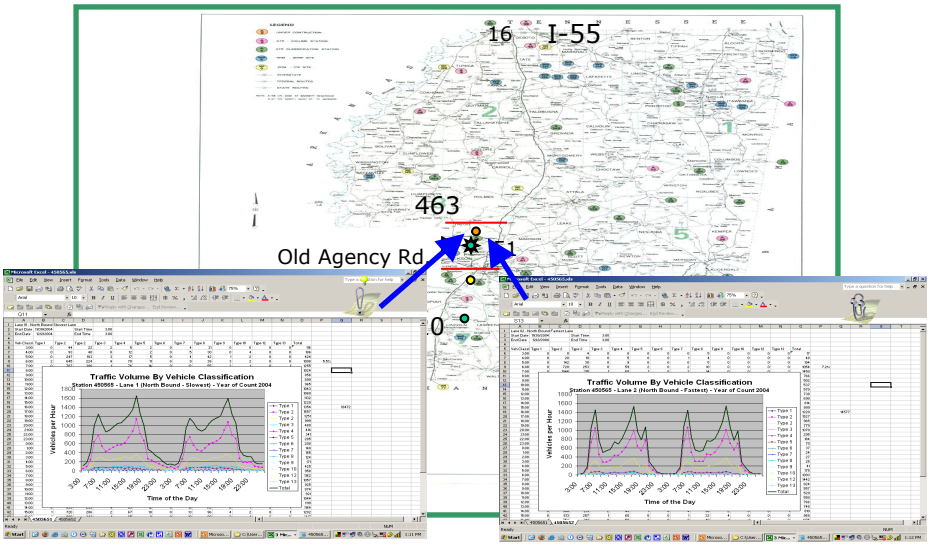

Figure 5. Traffic Volume Discriminated by Vehicle Classification
North Bound North of the Construction Zone

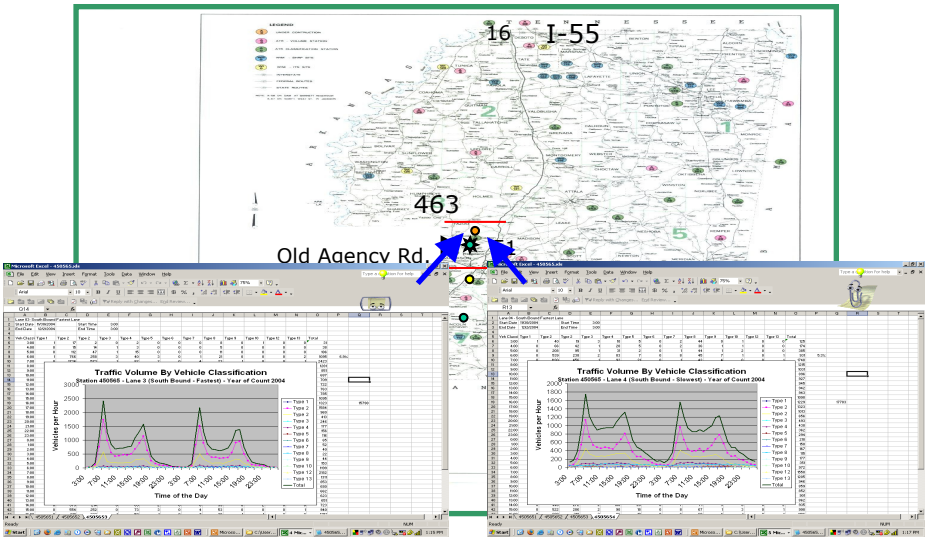

Figure 6. Traffic Volume Discriminated by Vehicle Classification
South Bound North of the Construction Zone

Additionally, the traffic volume was categorized in non-commercial, commercial light, and commercial heavy. In the south and north proximities of the studied area, the percentage of non-commercial vehicles were 91% and 83% respectively. Figure 7, shows the distribution of the average daily traffic with the categories in the proximities and significantly north of the studies area.

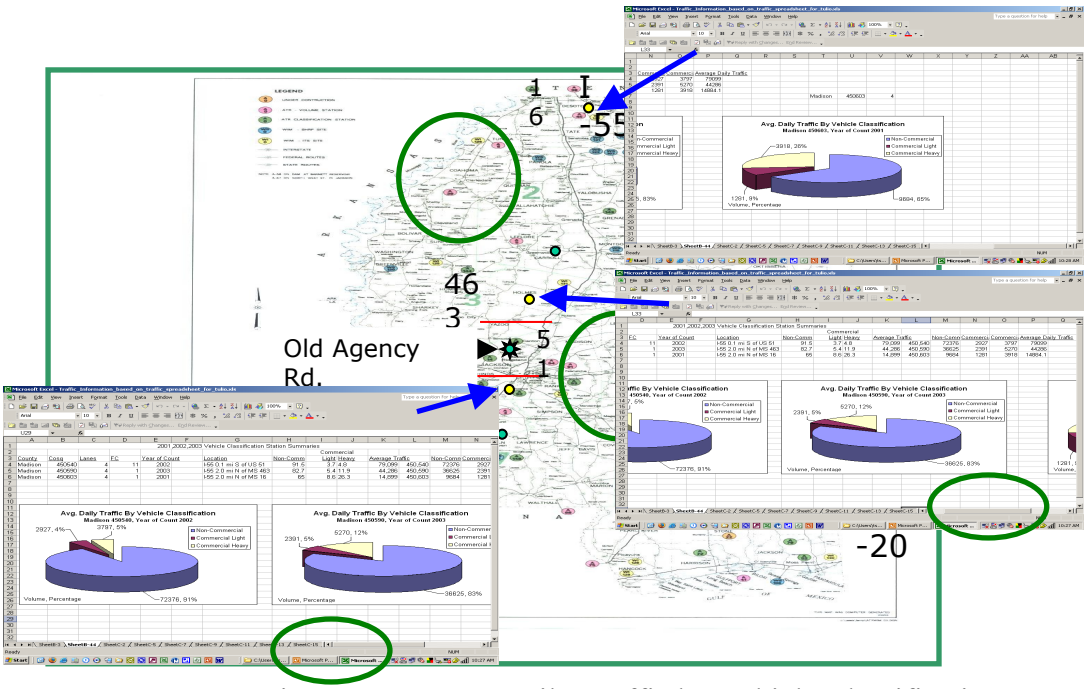

Figure 7. Average Daily Traffic by Vehicle Classification

d- Volume Hourly Peaks

The studied area traffic volume was characterized by having the 50th highest hourly traffic volume counts with more than 8.5% percent of the AADT in the year 2003. Figure 8 shows for Station 54 (south of the studied area) the relationship between the 50th highest hourly traffic volume counts and the percentage of the AADT.

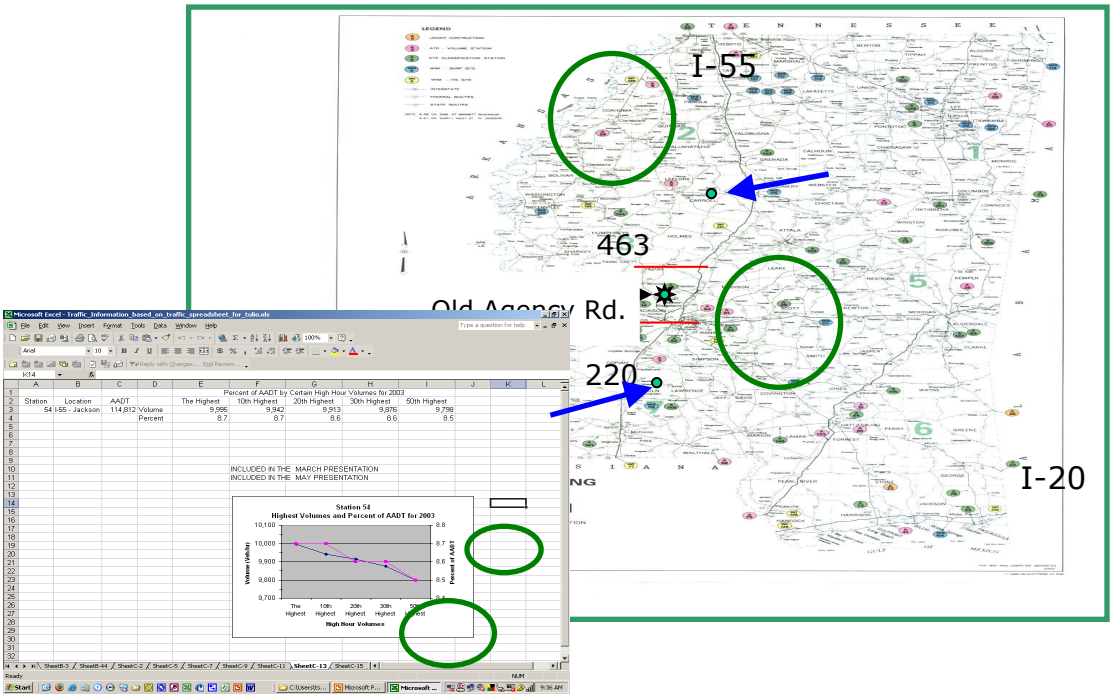

Figure 8. Highest Volumes as Percentage of AADT

e- Number of Citations – Ridgeland Police Department and Mississippi Highway Patrol

The Ridgeland Police Department (RPD) and the Mississippi Highway Patrol (MHP) contributed with the increased surveillance in the studied area. The number of citations from RPD and MHP varied significantly from week to week but over time the number of citations had a tendency to lower. Figure 5-9 shows the number of citations issued by the MHP in the studied area from January 8, 2003 till June 25, 2003. Figure 5-10, shows the number of citations issued by the Ridgeland Police Department per week in the studied area from August 15,2003 till June 11, 2004.

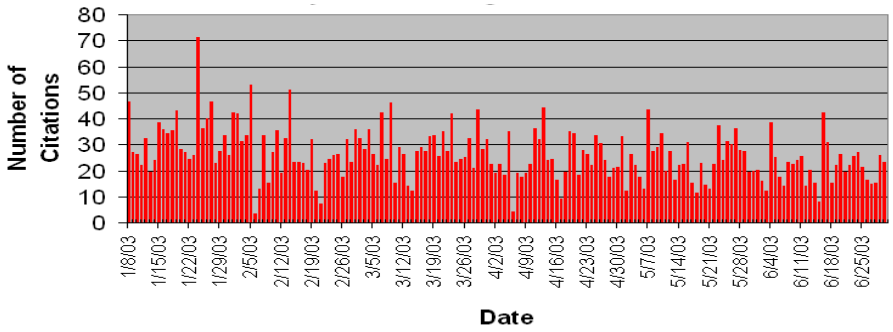

Figure 9. Number of Citations issued by
the Mississippi Highway Patrol (MHP) in the studied area

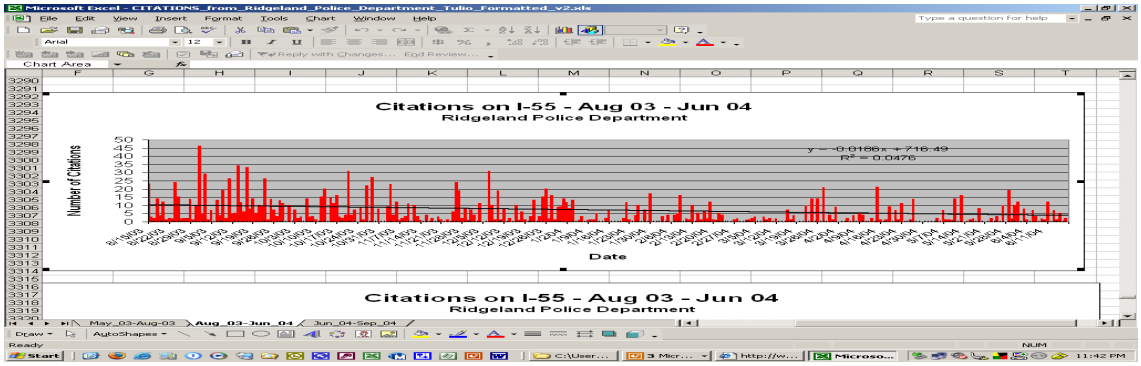

Figure 5-10. Number of Citations issued by
the Ridgeland Police Department (RPD) in the studied area

f- Number of Crashes

There were between 0 and 4 reported crashed per month on I-55 in the studied area. Figure 5-11, shows the number of reported crash from January 2000 till December 2003

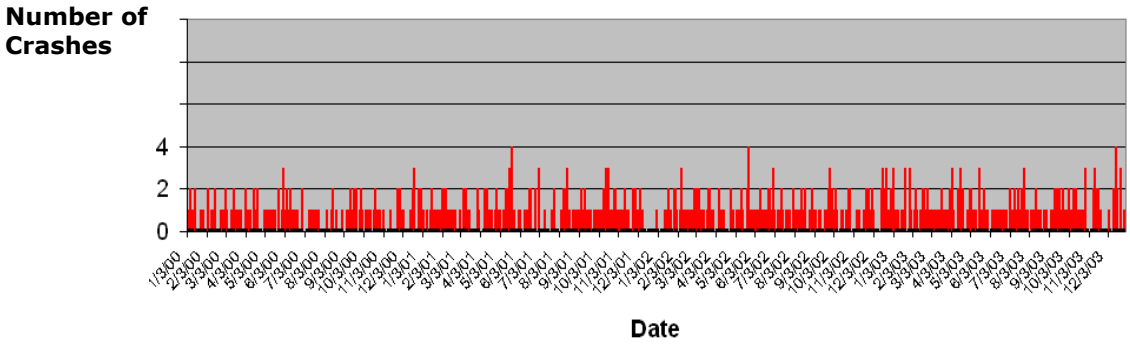

Figure 5-11. Reported Crashes on I-55 in the Studied Area

Lessons Learned

It is worth noting that this first project from the Mississippi Department of Transportation to quantitatively document the safety impact of increased law enforcement surveillance on highway construction was a success. It provided quantitative evidences of the program effectiveness. It also helps develop a sample process to evaluate other programs in the future and identify the data required for those evaluations. Some of the data required for similar evaluations include: timeframe of the intervention (in this case the law enforcement presence in the studied area), number of citations issued by law enforcement agencies over time, number of crashes in the studied area over time and hourly traffic volume in the studied area over time. Histograms, line charts, and scatter plots seems to be the most practical type of chart to present the gathered data.

Summary

One of the special measures implemented, in construction zones by several departments of transportation around the United States, to reduce the number of crashes is the increase of law enforcement surveillance. This article focuses on the descriptive statistical analysis to quantify the impact of law enforcement in construction zones.

The results presented in this article indicate that the permanent presence of law enforcement agencies in the studied area significantly increased the number of citations issued. This number of citations is reduced as law enforcement agencies stay in the studied area over time. It was also determined that there was not a direct correlation between the number of citations issued and the number of crashes. The number of crashes however was directly related to the traffic volume in the studied area.

It is also expected that the results and process presented in this paper could be used by other research teams to perform similar analysis of law enforcement surveillance or others methods implemented around the U.S. to reduce the deaths and injuries in road construction zones.

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