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CHARACTERISTICS OF RED LIGHT RUNNING CRASHES IN FLORIDA

by

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A thesis submitted in partial fulfillment of requirements for the degree of Master of Science in the Department of Civil, Environmental and Construction Engineering in the College of Engineering and Computer Science at the University of Central Florida Orlando, Florida

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Red light running is one of the main contributing factors of crashes in urban areas in Florida and the United States. Nationwide, according to preliminary estimates by the Federal Highway Administration (FHWA) 2001, there were nearly 218,000 red-light running crashes at intersections. These crashes resulted in as many as 181,000 injuries and 880 fatalities, and an economic loss estimated at $14 billion per year nationwide,

According to the Community Traffic Safety Team Florida Coalition (A statewide traffic safety group) there were 9,348 crashes involving red-light running in Florida and 127 fatalities in 1999. This research study focused on studying the red light running crashes and violations in the State of Florida.

There were three primary objectives for this research. The first primary objective was to analyze the red light running crashes in Florida from 2002 to 2004. The data for this part was collected from the Crash Analysis Reporting System of the Florida Department of Transportation. These crashes are reported as “disregarded traffic signal” as far as the first contributing cause. The analysis focused on the influences of different factors on red light running crashes including the driver (age group, gender, and DUI history) and the environment (time of day, day of week, type of road, and weather).

However, not all red light crashes are reported as “disregarded traffic signal”. Therefore, representing red light running crashes only through “disregard traffic signal” noted reports would underestimate the extent of red light running effects at a given intersection. Therefore, the second
objective was to review the long form crash reports to determine the actual number of crashes related to red light running.

The analysis for a random sample of the crashes on the state roads of Florida on the year 2004 showed that the percentage of crashes related to red light running reported on the database was found to be (3.13%), and the percentage of crashes related to red light running reported in the original crash report filled by the police officer are much higher than reported(5.63%), which shows the importance of standardizing the format and coding process for the long form crashes conducted by the police officers to help accurately identify the real cause of the crash at the studied location.

The third objective was to analyze the violations data given for five intersections and find if there is a correlation between the average rate of violations per hour and the frequency of red light running crashes.

The analysis showed that utilizing the limited number of intersections used in the study, it appears that there is no correlation between the average violations per hour and the red light running crashes at the studied locations.
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TABLE OF CONTENTS

LIST OF FIGURES ..................................................................................................................... ix
LIST OF TABLES ........................................................................................................................ x

CHAPTER 1 INTRODUCTION ................................................................................................. 1
  1.1 Background ........................................................................................................................... 1
  1.2 Research Objectives .............................................................................................................. 2
  1.3 Organization of the Thesis .................................................................................................... 3

CHAPTER 2 LITERATURE REVIEW ..................................................................................... 4
  2.1 Characteristics of Red Light Running Crashes ................................................................. 4
  2.2 Correlation Between Red Light Running Violations and Red Light Running Crashes ..... 6
  2.3 Identifying Locations with Red Light Running Problems ................................................. 8
  2.4 Countermeasures to Red Light Running ............................................................................. 9
  2.5 Different Enforcement Methods ....................................................................................... 11
    2.5.1 Single-Officer Technique ............................................................................................. 11
    2.5.2 Team Technique ........................................................................................................... 12
    2.5.3 Enforcement-Light Technique ..................................................................................... 12
    2.5.4 Camera Enforcement ................................................................................................... 13
  2.6 Reliability of the Crash Data ............................................................................................... 14
  2.7 Summary Of The Literature Review ................................................................................... 16

CHAPTER 3 TRENDS OF RED LIGHT RUNNING RELATED CRASHES IN FLORIDA .......... 19
  3.1 Data Collection ................................................................................................................... 19
  3.2 Rates of Red Light Running Crashes .................................................................................. 20
  3.3 Types of Movements ........................................................................................................... 21
  3.4 Types of Crashes ................................................................................................................. 22
  3.5 Influence of Driver on Red Light Running Crashes ........................................................... 23
    3.5.1 Gender .......................................................................................................................... 23
    3.5.2 Age ............................................................................................................................... 25
    3.5.3 DUI History ................................................................................................................. 28
  3.6 Influence of the Environment on Red Light Running Crashes ........................................... 29
    3.6.1 Time of Day ................................................................................................................. 29
    3.6.2 Day of Week ................................................................................................................ 30
    3.6.3 Type of Road ................................................................................................................ 31
    3.6.4 Weather ....................................................................................................................... 33
    3.6.5 Crash Injury Severity ................................................................................................... 34
  3.7 Main Findings ..................................................................................................................... 36

CHAPTER 4 RELIABILITY of crash data ............................................................................. 38
4.1 Introduction ......................................................................................................................... 38
4.2 Data Sources ....................................................................................................................... 38
  4.2.1 The Crash Analysis Reporting System (CAR) ............................................................ 39
  4.2.2 Safety Electronic Document Management System (SEDMS) .................................. 40
  4.2.2.1 Page 1 ................................................................................................................ 40
  4.2.2.2 Page 2 ................................................................................................................ 45
  4.2.2.3 Page 3 ................................................................................................................ 50
  4.2.2.4 Page 4 ................................................................................................................ 52
4.3 Study Site Selection ............................................................................................................ 54
  4.3.1 SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail) ........................................... 55
  4.3.2 SR 50 (West Colonial Drive) and North Hiawassee Road ......................................... 56
  4.3.3 US 17-92 (Orange Blossom Trail) and Sand Lake Road ............................................. 57
  4.3.4 US 17-92 (Orange Blossom Trail) and Taft Vineland Road ....................................... 59
  4.3.5 US 17-92 (Orange Blossom Trail) and West Holden Avenue ..................................... 60
4.4 Data Analysis ...................................................................................................................... 61
  4.4.1 SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail) ........................................... 63
  4.4.2 SR 50 (West Colonial Drive) and North Hiawassee Road ......................................... 64
  4.4.3 US 17-92 (Orange Blossom Trail) and Sand Lake Road ............................................. 64
  4.4.4 US 17-92 (Orange Blossom Trail) and Taft Vineland Road ....................................... 65
  4.4.5 US 17-92 (Orange Blossom Trail) and West Holden Avenue ..................................... 65
4.5 Comparison between the CAR System and the Long Form Crash Reports ....................... 66
  4.5.1 Failed to Yield Right-of-Way ...................................................................................... 68
  4.5.2 All Other .................................................................................................................... 69
  4.5.3 Careless Driving ......................................................................................................... 69
  4.5.4 Improper Turn ............................................................................................................ 69
  4.5.5 No Improper Driving ................................................................................................. 69
  4.5.6 Disregard Other Traffic Signal .................................................................................... 69
  4.5.7 Other Coding Problems .............................................................................................. 70
    4.5.7.1 Not Filling the Contributing Cause .................................................................... 70
    4.5.7.2 Coding the Driver at Fault as Second Driver .................................................... 70
    4.5.7.3 Having More Than One Contributing Cause .................................................... 70
    4.5.7.4 Having More Than One Contributing Cause .................................................... 70
4.6 Comparison between Type of Crashes (Left Turn Against Right Angle) .......................... 71
4.7 Comparison Between Type of Movements (Left Turning Against Through) ..................... 72
4.8 Involvement of Left Turn and Through Movement in Red Light Running Crashes .......... 73
4.9 Reliability of Crash Data in Large Scale ............................................................................ 77
4.10 Data Collection ................................................................................................................. 77
4.11 Analysis ............................................................................................................................. 77
  4.11.1 All Other .................................................................................................................. 79
  4.11.2 Failed to Yield Right-of-Way .................................................................................... 79
  4.11.3 Careless Driving ....................................................................................................... 80
  4.11.4 No Improper Driving ............................................................................................... 80
4.11.5 Improper Turn ............................................................................................................ 80
4.11.6 Disregard Other Traffic Signal .................................................................................. 80

CHAPTER 5 Correlation Between Red Light Running Violations And Red Light Running
Crashes ....................................................................................................................................... 81
5.1 Correlation between Red Light Running Violations And Red Light Running Crashes .... 81
  5.1.1 SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail) ........................................... 85
  5.1.2 SR 50 (West Colonial Drive) and North Hiawassee Road) ...................................... 87
  5.1.3 US 17-92 (Orange Blossom Trail) and Sand Lake Road ........................................ 88
  5.1.4 US 17-92 (Orange Blossom Trail) and Taft Vineland Road .................................... 90
  5.1.5 US 17-92 (Orange Blossom Trail) and West Holden Avenue ................................ 92
5.2 Correlation between Total Crash Rate and the Average Red Light Running Violations ... 94

CHAPTER 6 Conclusions and recommendations ................................................................ 96

REFERENCES .......................................................................................................................... 101
LIST OF FIGURES

Figure 3.1: Rate Of Red Light Running Crashes Per 1,000 Licensed Drivers ........................................... 21
Figure 3.2: Type of Movement .................................................................................................................. 22
Figure 3.3: Type of Crash ....................................................................................................................... 23
Figure 3.4: Gender ................................................................................................................................... 24
Figure 3.5: Number of Crashes Related to Red Light Running per 10,000 Licensed Drivers ................ 27
Figure 3.6: Rate of DUI Red Light Runners 100,000 Licensed Drivers .................................................. 28
Figure 3.7: Time of the Day .................................................................................................................... 29
Figure 3.8: Day of the Week .................................................................................................................... 30
Figure 3.9: Type of Road per 1,000 Mile .................................................................................................. 32
Figure 3.10: Weather ............................................................................................................................... 33
Figure 3.11: Red Light Running % of Crash Injury Severity ..................................................................... 35
Figure 4.1: Sample of the Report from the CAR System ......................................................................... 39
Figure 4.2: Long Form Crash Report Sample – Page 1 ......................................................................... 44
Figure 4.3: Long Form Crash Report Sample – Page 2 ......................................................................... 49
Figure 4.4: Long Form Crash Report Sample – Page 3 ......................................................................... 51
Figure 4.5: Long Form Crash Report Sample – Page 4 ......................................................................... 53
Figure 4.6: SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail) ......................................................... 55
Figure 4.7: SR 50 (West Colonial Drive) and North Hiawassee Road ....................................................... 56
Figure 4.8: US 17-92 (Orange Blossom Trail) and Sand Lake Road ......................................................... 58
Figure 4.9: US 17-92 (Orange Blossom Trail) and Taft Vineland Road .................................................... 59
Figure 4.10: US 17-92 (Orange Blossom Trail) and West Holden Avenue ............................................... 60
Figure 4.11: Different Contributing Causes .............................................................................................. 68
Figure 4.12: Red Light Running Crashes Per Type of Crash ..................................................................... 71
Figure 4.13: Red Light Running Related Crashes Per Type of Crash ......................................................... 72
Figure 4.14: Red Light Running RelatedCrashes Per Type of Crash .......................................................... 73
Figure 4.15: Example Of The Error In Coding The Red Light Running Type Of Crash ......................... 75
Figure 4.16: Coding The Left Turn Red Light Running Crash As Angle Crash ........................................ 76
Figure 4.17: Intersection 4 – Different Contributing Causes for the Random Sample .............................. 79
Figure 5.1: Intersection 1 - Correlation between Red Light Running Violations and Red Running Crashes ............................................................................................................................................. 86
Figure 5.2: Intersection 2 - Correlation Between Red Light running Violations And Red Light Running Crashes ........................................................................................................................................... 88
Figure 5.3: Intersection 3 - Correlation between Red Light Running Violations and Red Light Running Crashes ........................................................................................................................................... 89
Figure 5.4: Intersection 4 - Correlation Between Red Light running Violations And Red Light Running Crashes .......................................................................................................................................... 91
Figure 5.5: Intersection 5 - Correlation between Red Light Running Violations and Red Light Running Crashes ........................................................................................................................................... 93
LIST OF TABLES

Table 2.1: Countermeasures to Red Light Running ................................................................. 11
Table 3.1: Number of Female and Male Licensed Drivers (FHWA) ........................................ 24
Table 3.2: Number Driver Licenses and Red Light Running For Each Age Group (FHWA) .... 25
Table 3.3: Rate of Red Light Runner per 10000 Licensed Drivers for Each Age Group .......... 26
Table 3.4: Analysis of Variance between the Rate Red Light Runners /10000 licensed drivers for each year .......................................................... 26
Table 3.5: Total Vehicle Mile Traveled and Red Light Running Crashes in Rural & Urban Roads (FHWA) ............................................................................. 31
Table 3.6: Total Amount of Damage, Total Number of Injuries and Total Number of Fatalities From Red Light Running Crashes ........................................................................ 35
Table 4.1: Geometric Characteristics of the Studied Sites ....................................................... 54
Table 4.2: Traffic Signal Characteristics of the Studied Sites ................................................ 54
Table 4.3 Total Crash Frequency for Each Intersection ......................................................... 61
Table 4.4 Red Light Running Crash Frequency for Each Intersection from the CAR System* . 62
Table 4.5 Red Light Running Crash Frequency for Each Intersection from the Long Form Reports ......................................................................................... 62
Table 4.6 Red Light Running Crashes Contributing Cause from the Long Form Reports ....... 63
Table 5.1: Red Light Running Crash Rate Per One Million-Crossing Vehicle ...................... 81
Table 5.2: Red Light Running Violations Data Sample ........................................................ 83
Table 5.3: Total Violations Per Lane Type ............................................................................. 84
Table 5.4: Total Recorded Hours Of Violations Per Lane Type ............................................. 84
Table 5.5: Average Violations Per Hour Per Lane Type ......................................................... 85
Table 5.6: Red Light Running Crashes Per Lane Type .......................................................... 85
Table 5.7: Red Light Running Crash and Violation Rate Per One Million-Crossing Vehicle.... 95
CHAPTER 1 INTRODUCTION

1.1 Background

Every year several hundred thousand crashes occur on public roadways in the United States. According to the annual report from National Highway Traffic Safety Administration (NHTSA) for the year 2006, the number of people killed in the United States in motor vehicle traffic crashes was 42,642. In addition, the number of people injured in motor vehicle traffic crashes in 2006 was approximately 2.6 million people.

A crash is an occurrence in which at least one motor vehicle crashes on a public roadway. These collisions cost millions of dollars in both property damages and medical care costs. Retting et al. (1998) reported that about one million collisions occur at signalized intersections in the U.S. every year. Of these collisions, Mohamedshah et al. (2000) estimated that at least 16 to 20 percent could be attributed directly to red light running. Retting et al. also reported that motorists involved in red-light-running-related crashes are more likely to be injured than those in other crashes. In fact, they found that 45 percent of red-light-running-related crashes involve injury whereas only 30 percent of all other crashes involve injury.

One factor that contributes to multiple-vehicle crashes at intersections, as well as those involving pedestrians, is noncompliance with traffic control devices such as stop signs and traffic...
signals. In fact, such traffic violations are a major cause of urban motor vehicle crashes. In a study of police-reported crashes from four urban areas, Retting et al. (1999) found that “ran traffic control” was the single most common type of crash, accounting for 22 percent of all urban crashes and 27 percent of injury crashes. This same study found that injuries were more likely in collisions involving red light running than in other crash types; injuries were reported in 45 percent of red light running crashes compared with 30 percent for other crashes. The purpose of this thesis is to study the characteristics of red light crashes in Florida and compare it with general characteristics reported in other studies.

1.2 Research Objectives

None of the studies in the literature review was focused on the red light running crashes in Florida or the errors in coding the crash report, which indicated the need for our study.

Red light running is a primary cause of crashes in urban areas in Florida and the United States. The first goal of this study is to analyze the red light running crashes in Florida from 2002 to 2004 using data from the Florida Department of Transportation.

The second goal of this study is to analyze the actual hard copy crash reports and compare them with the data obtained from the database to investigate if errors often occur in how information on a red light running crash report is coded in the computerized crash database.

The final goal of the current research work is to examine whether red light crashes occur more frequently at intersections with high red light violations.
1.3 Organization of the Thesis

Following this introductory chapter, a detailed literature review of studies that investigate red light running violations and red light crashes is presented in Chapter 2. In Chapter 3, trends of red light running crashes were analyzed using three years (2002-, 2003, and 2004) of Florida crash data provided by the Department of Highway Safety & Motor Vehicle (DHSMV).

Chapter 4 discusses the comparison between the data obtained from the actual hard copy crash reports and the data coded in the computerized crash database for five intersections in Orange County, Florida. In addition, Chapter 4 discusses the comparison between the data obtained from the actual hard copy crash reports and the data coded in the computerized crash database for a random sample from the state of Florida. Chapter 5 describes graphically the correlation between red light violations and red light crashes for the same five intersections. Finally, Chapter 6 summarizes the conclusions from the analyses and further avenues are suggested.
CHAPTER 2 LITERATURE REVIEW

This part of the study summarizes some of the research in the area of red light running crashes and red light running prediction models, and factors correlated with red light violation frequency.

2.1 Characteristics of Red Light Running Crashes

Retting et al. (1995) found that 56 percent of crashes occur at intersections based on a sample of 4,526 crash reports from four urban areas around the country (Akron, OH; New Orleans, LA; Yonkers, NY; and Arlington County, VA). They found “ran traffic control” to be the most common type of crash, accounting for 22 percent of urban crashes and 27 percent of injury crashes. They also found injuries were more likely in “ran traffic control” crashes than in other types of crashes: 45 percent of “ran traffic control” crashes had injuries vs. 30 percent for other crashes.

Retting et al. (1996) conducted research to develop a profile of red light runners. To identify characteristics of drivers that run red lights, 1,373 observations (462 violators and 911 red light compliers) were taken in Arlington, Virginia in 1994 and 1995. Violators were found to be younger, less likely to wear seat belts, possess poorer driving records, and drive smaller and...
older vehicles than those that complied. Red light runners were also found to be more likely to have multiple speeding convictions on their driving records.

Retting et al. (1999) analyzed fatal red light running crash trends using data from 1992 to 1996 from the FARS and GES databases. For the analysis, the researchers only considered fatal crashes in which one driver had committed a red light running violation and both drivers were going straight prior to the crash. Based on their analysis they found some 86 percent of fatal red light running crashes occurred on urban roads. By comparison, 42 percent of other fatal crashes occurred on urban roads. Cities with a population of 200,000 or more accounted for 34 percent of all fatal red light running crashes. For those cities, the average rate of fatal red light running crashes was 2.5 crashes per 100,000 residents with variations between 0.21 and 8.11 crashes per 100,000 residents. Both fatal red light running crashes (91 percent) and other fatal crashes (87 percent) occurred primarily during good weather conditions. Some 57 percent of fatal red light running crashes occurred during the day. By comparison, 48 percent of other fatal crashes occurred during the day. However, fatal red light running crashes that involved drivers less than 70 years old peaked around midnight, whereas fatal red light running crashes that involved drivers 70 years old or older occurred primarily during the day.

Hu and Young (1999) found that besides age, gender also was a factor in fatal crashes. On average, 74 percent of red light runners and 70 percent of non-runners were male. Of all nighttime red light runners, 83 percent were male. Of all daytime red light runners, 67 percent were male. It may be worth noting that male drivers accounted for roughly 61 percent of the vehicle miles traveled on U.S. roads. Some 43 percent of red light runners were younger than age
30. By comparison, 32 percent of non-runners were younger than age 30. Police suspected alcohol involvement in about two-thirds of drivers involved in fatal red light running crashes. Police suspected alcohol consumption much more frequently in the case of red light runners than in the case of non-runners (34 percent vs. 4 percent), respectively. Red light runners were much more likely to drive with suspended, revoked, or otherwise invalid driver licenses. Younger drivers were more likely to be unlicensed. Differences in past crash history between red light runners and non-runners were not significant. However, red light runners were significantly more likely to have prior convictions for driving while intoxicated and two or more moving violation convictions of any type.

2.2 Correlation Between Red Light Running Violations and Red Light Running Crashes

Retting et al. (1997) investigated the effect of signal timing on red light compliance. The Manual on Uniform Traffic Control Devices (MUTCD) suggests that typical yellow (change) intervals be from three to six seconds in length, with allowances for longer intervals where traffic speeds are higher. The length of all-red (clearance) intervals is largely a function of traffic speed and width of the intersecting street.

Mohamedshah et al. (2000) used crash data obtained from the State of California to develop a model for predicting the frequency of red-light-related crashes on an intersection approach. Varieties of factors were considered in the calibration of a prediction model. These factors included: annual average daily traffic (AADT) on both intersecting streets, number of lanes crossed (i.e., clearance distance), presence of left-turn bays, and type of traffic control (i.e.,
pretimed, actuated, or semi-actuated). The data reported by Mohamedshah et al. were used to examine the effect of clearance distance on red-light-related crashes. This examination indicated that crash frequency is somewhat insensitive to clearance distance for distances up to 130 ft. However, crashes were found to increase with clearance distances in excess of 130 ft.

Bonneson et al. (2002) found that there was a positive correlation between red light running violations and related crashes. Hence, it is logical that factors that influence violations may also influence crash frequency. In fact, he found that the following factors were correlated with violation frequency: approach flow rate, cycle length, yellow interval duration, running speed, clearance path length, platoon ratio, use of signal head back plates, and use of advance detection. In general, a decrease in violations was found to be associated with a decrease in flow rate, an increase in yellow duration, and a decrease in speed, an increase in clearance path length (i.e., a wider intersection), a decrease in platoon density, and the addition of signal head back plates.

Bonneson and Zimmerman (2006) documented the development of a procedure for identifying and ranking intersections approaches with the potential for improvement in the area of red-light-related crashes. One component of this procedure is a safety prediction model. A sensitivity analysis of this model indicated that red-light-related crashes decrease with an increase in yellow interval duration and a reduction in speed limit.
2.3 Identifying Locations with Red Light Running Problems

The identification of an intersection with a red-light-running problem is typically based on consideration of several criteria. These criteria range from the frequency of red-light running violations, to the frequency of red-light-running-related crashes, to the frequency of citizen complaints. Most of these criteria are based on quantitative data.

Milazzo et al. (2001) indicated that six cities in North Carolina use only the frequency of right angle crashes to identify problem locations. They often attempted to confirm the existence of the problem through on-site observation and conversations with enforcement agencies. Finally, when deciding whether to use camera enforcement, the city works with an automated enforcement vendor to determine which locations will produce a sufficient number of violations to offset the cost of the enforcement equipment and its operation. It was noted that one vendor requires an intersection approach to experience a minimum of 25 violations per day before it can justify the installation of its equipment at that location.

A crash-frequency-based procedure is also used by Howard County, Maryland to identify problem intersections. Walter (2000) indicated that county engineers review right-angle crash data to identify problem locations. Then, they conduct a field study of red-light-running frequency. If there are more than 30 red-light running violations per day, the cost of installing and operating camera enforcement equipment was determined to be justified.

Bonneson et al. (2002) described an alternative method for locating problem intersections. This method considered both red-light running violations and related crashes. Instead of looking at just the total number of violations, the method focuses on the difference
between the observed and expected violations (where the expected violations represent an average for a group of typical intersections of similar volume). Problem intersections are defined as those having a large difference between the observed and expected violations. Additional consideration is given to those intersections with a recurring frequency of red-light-running-related crashes. The advantage of this approach is that it is intended to direct resources to truly abnormal locations (i.e., locations where efforts to implement a countermeasure will be cost-effective).

### 2.4 Countermeasures to Red Light Running

Several individuals have investigated the causes of red-light-running and reviewed the practices of agencies dealing with the associated problems. Each has recommended that a traffic engineering study precede the implementation of engineering countermeasures. A study was conducted to identify factors that might be contributing to the red-light-running problem. These factors may include yellow interval duration, signal head visibility, unusual geometry, or excessive delay. Measurements of signal violation and conflict frequency were suggested as being useful in quantifying the extent of the problem. Information obtained from the study would then be used to identify the most cost-effective combination of engineering countermeasures.

Engineering countermeasures can be placed into three categories, depending on their method of implementation. These categories are identified in Table 2.1 along with some common countermeasures. Signal Operation countermeasures are implemented through modification to the signal phasing, cycle length, or yellow interval. Motorist Information
countermeasures are implemented through enhancements to the signal display or by providing advance information to the driver about the existence of a signal ahead. The Physical Improvement category includes a group of more substantial modifications to the intersection that are intended to solve serious safety or operational problems. The effectiveness data presented reflects the findings from a combination of before-after studies and a review of the literature by Bonneson et al. (2002). In general, the percentages associated with red-light running violation frequency are likely to be more reliable than those for red-light-running-related crashes. This observation is based on a review of the statistical techniques that underlie the reported percentages. The effectiveness of some countermeasures is not shown in Table 2.1 because they have not been formally studied. Nevertheless, their ability to reduce red-light running violations and related crashes is intuitive and widely recognized, especially when operations or visibility are improved by their implementation.
There are different techniques to address the red light running problem including officer related enforcement and/or camera related enforcement techniques.

2.5.1 Single-Officer Technique

The traditional approach for enforcing traffic control laws involves stationing one officer upstream of a signalized intersection such that he or she has a direct view of both signal
indications and any vehicles approaching the intersection. If the officer witnesses a red-light running violation, he or she can then pursue, stop, and cite the violator. However, following the violator into the intersection is dangerous for both the officer and the other motorists that may be entering the intersection per Hansen (1998).

2.5.2 Team Technique

To address the safety concern associated with the single-officer enforcement technique, some police departments have experimented with a team enforcement technique. With the team technique, one officer is stationed upstream of the signalized intersection, and a second officer is located downstream of the intersection. When the “upstream” officer observes a violation, he or she sends a radio message to the “downstream” officer, who then proceeds to stop and cite the violator. Team enforcement techniques had a higher red-light-running citation rates and are considered safer for officers than the single-officer technique per Hansen (1998).

2.5.3 Enforcement-Light Technique

As an alternative to team enforcement, some jurisdictions use enforcement lights (also called “rat boxes,” “red eye devices,” or “tattletale lights”) per Milazzo (2001). An enforcement light can be attached to the signal head or to the signal mast arm. These lights are illuminated while the traffic signal indication is red. They allow a single officer stationed downstream of the signal to observe vehicles entering the intersection and note whether the signal indication is red. Enforcement lights eliminate the need for team enforcement and thus, have a lower operating cost.
2.5.4 Camera Enforcement

As a new technique, some jurisdictions use camera systems as an enforcement method. Camera systems have been used in different countries around the world for years. These initiatives have not been used in the United States until recently however. Cities across the country are increasingly using automated programs to help enforce traffic laws by photographing or recording vehicles and/or drivers who violate statutes. Photographic evidence is then used to cite the violators. Automated red light enforcement programs are costly to establish. However, this technology can increase the productivity of traditional police enforcement by freeing resources to address other duties (Kamyob 2000).

Enforcement cameras can have three purposes. First, cameras are used to enforce traffic signal compliance. Images captured by cameras are used to provide clear and possibly indisputable evidence of violations. Second, enforcement cameras can reduce the frequency of red light running occurrences. Red light running cameras have proven to effectively reduce crashes and fatalities resulting from signal violations in many cities. Third, cameras can be used to generate revenue through increased citations. Often this revenue can be used to defray the costs associated with the implementation and operation of the enforcement program.

The positioning of the camera is relative to the intersection. The violation for red-light-running may be treated as a civil or criminal offense, depending on the relevant state statutes. Tickets for civil offenses or warnings are sent by mail to violators. Prosecution of the violation as a criminal offense requires proof that the individual committed the offense (e.g., a frontal photograph) and is adjudicated in a criminal court with a fine levied by a judge.
2.6 Reliability of the Crash Data

The main source of any crash related study is the crash databases. Sometimes the crash databases do not provide accurate information about the crashes. Consequently, researchers have sometimes turned to the actual hard copy crash reports filed by victims and/or law enforcement personnel who investigated the report.

Wang and Abdel-Aty (2007) studied the crashes from 2000 to 2005 for 197 four-legged signalized intersections from Orange and Hillsborough counties in the Central Florida area. They studied 13,218 crashes obtained from the Crash Analysis Reporting (CAR) system maintained by the Florida Department of Transportation (FDOT), which is the most complete crash database for the state road intersections in Florida. The purpose of studying the crashes was to identify the angle collisions attributed to RLR. Of 2431 initial angle collisions, 836 were right-angle crashes. Another 97 crashes which were classified as non-angle were considered as right-angle crashes by inspecting their original crash reports through the state crash report document image retrieval system. The proportion of right-angle crashes among angle crashes was 34.4%; and 10.4% of right-angle crashes were from other crash types, which shows the importance the crash reports to obtain accurate information about the studied crashes.

Wang and Abdel-Aty (2007) also studied the data for 177 four-legged signalized intersections were collected from Florida to investigate how intersection attributes affect this safety influence area and how the varied safety influence areas for intersection approaches improve safety analysis. In the state of Florida, crashes within 50 feet of an intersection are classified as “at intersection”; when crashes are within 250 feet of an intersection, the site
locations are recorded as “influenced by intersection.” The crash location distance is supposed to be measured from the center of the intersection. In practice, when police officers determine the distance for a crash they are frequently measuring it from the stop bar rather than the center. Among the total 13,218 crashes for the selected intersections, there were 2276 crashes coded as “not at intersection” in the site location. A total of 1940 crashes were changed to “influenced by intersection” after reviewing the crash reports.

In order to better understand the underlying crash mechanisms, Wang and Abdel-Aty (2007) analyzed left-turn crashes occurring at 197 four-legged signalized intersections over 6 years. Initially, 1,575 left-turn crashes were determined from the Crash Analysis Reporting (CAR) system maintained by the Florida Department of Transportation (FDOT). In addition to the initial 1575 left-turn crashes, another 1523 crashes, which were originally recorded as other crash types, were determined as left-turn crashes since at least one of the involved vehicles was turning left by inspecting their crash reports through the state crash report image retrieval system. From reviewing the crash reports, it was also found that, for around 30% of left-turn crashes, left-turning vehicles’ traveling directions were recorded as the destination direction, but not the initiating direction before turning. This record error was corrected.

Based on the previous literature review, it is always important to go back to the original crash reports to obtain an accurate information about the crashes.
2.7 Summary Of The Literature Review

This section summarizes the findings of the literature review related to red light running, a comparison between our findings and findings from the previous literature reviews.

Findings from the literature review:

- The older age groups accounted for a relatively small portion of red light running crashes compared to the young age group.
- Red light violators were found to be younger, less likely to wear seat belts, possess poorer driving records, and drive smaller and older vehicles.
- Younger drivers were more likely to be unlicensed.
- Red light runners are more likely to be male.
- Higher red light running crashes occur during the PM time period.
- The influence of rainfall on red light running behavior is insignificant.
- “Ran traffic control” was found to be the most common type of crash at signalized intersections.
- Injuries were found to occur more likely in “ran traffic control” crashes than in other types of crashes:
- Red light runners were also found to be more likely to have multiple speeding convictions on their driving records or invalid driver licenses.
- Most fatal red light running crashes were found to occur on urban roads.
• It was found that crash frequency is somewhat insensitive to clearance distance for distances up to 130 ft. However, crashes were found to increase with clearance distances in excess of 130 ft.

• It was found that there was a positive correlation between red light running violations and related crashes.

• It was also found that the following factors were correlated with violation frequency: approach flow rate, cycle length, yellow interval duration, running speed, clearance path length, platoon ratio, use of signal head back plates, and use of advance detection. In general, a decrease in violations was found to be associated with a decrease in flow rate, an increase in yellow duration, a decrease in speed, an increase in clearance path length (i.e., a wider intersection), a decrease in platoon density, and the addition of signal head back plates.

• The identification of an intersection with a red-light-running problem is typically based on several criteria that range from the frequency of red-light running violations, to the frequency of red-light-running-related crashes, to the frequency of citizen complaints.

• Engineering countermeasures for red light running can be placed into three categories. Signal Operation countermeasures are implemented through modification to the signal phasing, cycle length, or yellow interval. Motorist Information countermeasures are implemented through enhancements to the signal display or by providing advance information to the driver about the existence of a signal ahead. The Physical
Improvement category includes a group of more substantial modifications to the intersection that are intended to solve serious safety or operational problems.

- There are different techniques to address the red light running problem including officer related enforcement and/or camera related enforcement techniques including single office technique, team technique, enforcement light technique, and camera enforcement.

  Findings From our research related to the literature review:
  
  - The older age group accounted for a relatively small portion of the red light running crashes compared to the young age group.
  - Red light runners were more likely to be male.
  - Higher red light crashes occurred during the PM time period.
  - There was no influence of the weather on red light running crashes.
  - There was no correlation found between the average red light violations per hour and the red light running crashes in the studied intersections.

  One of the important issues not covered in the literature review was the accuracy of the red light running crashes data used in these studies. It was important to understand if the data was coded correctly and represent the real number and type of red light running crashes. Therefore, there was a need to analyze the crash data obtained from different sources (actual hard copy crash reports) versus the data obtained from the database, to investigate if errors often occur in how information on a red light crash report was coded.

  None of the studies in the literature review was focused on the red light running crashes in Florida or the errors in coding the crash report, which indicated the need for our study.
CHAPTER 3 TRENDS OF RED LIGHT RUNNING RELATED CRASHES IN FLORIDA

3.1 Data Collection

A primary purpose of this research was to assess the scope and effects of traffic signal crashes in Florida. The analysis was conducted using three years of Florida crash data (2002-2004) provided by the Department of Highway Safety and Motor Vehicle (DHSMV) CD. These data were normalized by finding the total number of driver licensees, the number of driver licenses by age group, the number of male and female driver licenses, and the total vehicle mile traveled in Florida for the years (2002, 2003 and 2004). These information were found from the official website of the Federal Highway Administration (FHWA).

The information contained in the CAR system has been compiled from information collected for the purpose of identifying, evaluating, or planning safety enhancements. This system and its products identify information used for the purpose of developing highway safety construction improvement projects, which may be implemented utilizing Federal-aid highway funds by the Florida Department of Transportation (CAR Manual 2006).

In these analyses, only crashes with “Disregarded Traffic Signal” listed as “first contributing causes” for the entire state were used. Electronic data (20,752 crash records) for the three years (2002-2004) were obtained. Each record included date, harmful event (type of crash),
type of movement, second and third contributing cause, age, gender, injuries, fatalities, weather, and other related characteristics. It should be noted that these crashes does not present the real number of the red light running related crashes because we did not check the long form police report to check the accuracy of the electronic data base obtained from the DHSMV data base.

3.2 Rates of Red Light Running Crashes

The total number of licensed driver was obtained from the official website of the FHWA to be 12,744,055 for the year 2002, 12,905,812 for the year 2003, and 13,146,357 for the year 2004. This data is then used to normalize the number of red light running crashes to a rate per 1000 licensed drivers. The red light runner crashes were obtained from the electronic record (DHSMV) as disregard traffic signal and coded as (11). It was found that the red light running crashes are 7,075 for the year 2002, 6,934 for the year 2003, and 7,000 for year 2004.

The analysis showed that for the three years studied the rate of red light running crashes (was approximately one crash per 2,000 licensed drivers. (See Figure 3.1).
3.3 Types of Movements

According to the type of movement, which is coded in the database as (01) for through movement and (03) for left movement for the driver at fault, it was found that over 90% of the crashes related to red light running involved through vehicles. Less than 10% of the crashes related to red light running involved left turning vehicles (see Figure 3.2)
3.4 Types of Crashes

First Harmful Event shows the harmful event code listed first for the first at-fault vehicle. This event is coded from (01) to (39) and (77) according to the type of the crash occurred.

For example

01 = collision with motor vehicle in transport (rear end).
02 = collision with motor vehicle in transport (head on).
03 = collision with motor vehicle in transport (angle).
04 = collision with motor vehicle in transport (left turn).
77 = all other (explain in narrative).
Based on the analysis of the types of crashes, it was found that approximately 65% of the crashes were angle crashes and that approximately 10% of the crashes were left turn collisions as shown in (Figure 3.3).

![%1ST Harmful Event]

Figure 3.3: Type of Crash

3.5 Influence of Driver on Red Light Running Crashes

3.5.1 Gender

The total number of male and female licensed drivers for the years 2002, 2003, and 2004 was obtained from the official web site for FHWA as shown in Table 3.1; This data was used to normalize the frequency of red light running crashes for males and females to a rate per 10000 driver license.
A comparison of the demographic characteristics of the red light running related crashes; it was found that in the three studied years, people involved in red light running crashes are more likely to be males than females. On average, approximately 6 of every 10,000 male licensed drivers in Florida were involved in a red light running crash. Approximately 4 females out of every 10,000 female licensed drivers involved in a red light running crashes. See Figure 3.4 shows the number of drivers (male or female) per 10,000 licensed drivers involved in red running related crashes in the three studied years.

Table 3.1: Number of Female and Male Licensed Drivers (FHWA)

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Licensed Drivers</td>
<td>6,485,914</td>
<td>6,445,306</td>
<td>6,586,814</td>
</tr>
<tr>
<td>Female Licensed Drivers</td>
<td>6,419,899</td>
<td>6,298,749</td>
<td>6,559,543</td>
</tr>
</tbody>
</table>

Figure 3.4: Gender
3.5.2 Age

The total number of licensed drivers by age group for each year was obtained from the official site for FHWA as seen on Table 3.2. This data was used to normalize the red light runner crash frequency to get the rate per 10,000-driver license. We did the analysis of variance to see if there is a statistical difference between the rates of red light runners for the three years with 90% level of confidence ($\alpha = 0.1$). From the results in Table 3.4 the P-value = 0.99363, therefore we can conclude that there is a statistical difference between the results for each year so we should separate the results for each year.

After analyzing the data for the three years (2002-2004) it was found that the younger age groups (16 to 20 and 20 to 25 year old) are more likely to be involved in a red light running related crash compared to other age groups. The older age groups accounted for a relatively small portion of red light running crashes. Figure 3.5 shows the number of drivers per age group per 10,000 licensed drivers involved in a red light running related crash in the last three years. The U shape trend observed from this analysis is supported by previous research findings.

### Table 3.2: Number Driver Licenses and Red Light Running For Each Age Group (FHWA)

<table>
<thead>
<tr>
<th>AGE</th>
<th>02 RLR crashes</th>
<th>02 Driver License</th>
<th>03 RLR crashes</th>
<th>03 Driver License</th>
<th>04 RLR crashes</th>
<th>04 Driver License</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20</td>
<td>1,064</td>
<td>447,157</td>
<td>1,031</td>
<td>458,453</td>
<td>999</td>
<td>468,099</td>
</tr>
<tr>
<td>&gt;20-25</td>
<td>853</td>
<td>940,537</td>
<td>862</td>
<td>954,526</td>
<td>936</td>
<td>977,847</td>
</tr>
<tr>
<td>&gt;25-35</td>
<td>1,229</td>
<td>2,235,772</td>
<td>1,222</td>
<td>2,235,194</td>
<td>1,219</td>
<td>2,253,816</td>
</tr>
<tr>
<td>&gt;35-45</td>
<td>1,059</td>
<td>2,591,730</td>
<td>1,050</td>
<td>2,593,456</td>
<td>1,053</td>
<td>2,611,994</td>
</tr>
<tr>
<td>&gt;45-55</td>
<td>824</td>
<td>2,293,404</td>
<td>774</td>
<td>2,358,349</td>
<td>787</td>
<td>2,435,869</td>
</tr>
<tr>
<td>&gt;55-65</td>
<td>520</td>
<td>1,751,222</td>
<td>459</td>
<td>1,837,379</td>
<td>544</td>
<td>1,928,836</td>
</tr>
<tr>
<td>&gt;65-75</td>
<td>402</td>
<td>1,322,961</td>
<td>413</td>
<td>1,322,490</td>
<td>369</td>
<td>1,335,868</td>
</tr>
<tr>
<td>&gt;75-85</td>
<td>294</td>
<td>921,563</td>
<td>304</td>
<td>907,816</td>
<td>303</td>
<td>904,147</td>
</tr>
<tr>
<td>&gt;85</td>
<td>61</td>
<td>239,709</td>
<td>75</td>
<td>238,149</td>
<td>50</td>
<td>229,881</td>
</tr>
<tr>
<td>UNKNOWN</td>
<td>732</td>
<td>705</td>
<td>712</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.3: Rate of Red Light Runner per 10000 Licensed Drivers for Each Age Group

<table>
<thead>
<tr>
<th>AGE</th>
<th>Rate/10000 License (02)</th>
<th>Rate/10000 License (03)</th>
<th>Rate/10000 License (04)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-20</td>
<td>23.79</td>
<td>22.49</td>
<td>21.34</td>
</tr>
<tr>
<td>&gt;20-25</td>
<td>9.07</td>
<td>9.03</td>
<td>9.57</td>
</tr>
<tr>
<td>&gt;25-35</td>
<td>5.50</td>
<td>5.47</td>
<td>5.41</td>
</tr>
<tr>
<td>&gt;35-45</td>
<td>4.09</td>
<td>4.05</td>
<td>4.03</td>
</tr>
<tr>
<td>&gt;45-55</td>
<td>3.59</td>
<td>3.28</td>
<td>3.23</td>
</tr>
<tr>
<td>&gt;55-65</td>
<td>2.97</td>
<td>2.50</td>
<td>2.82</td>
</tr>
<tr>
<td>&gt;65-75</td>
<td>3.04</td>
<td>3.12</td>
<td>2.76</td>
</tr>
<tr>
<td>&gt;75-85</td>
<td>3.19</td>
<td>3.35</td>
<td>3.35</td>
</tr>
<tr>
<td>&gt;85</td>
<td>2.54</td>
<td>3.15</td>
<td>2.18</td>
</tr>
</tbody>
</table>

Table 3.4: Analysis of Variance between the Rate Red Light Runners /10000 licensed drivers for each year.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>0.533199</td>
<td>2</td>
<td>0.2666</td>
<td>0.006387</td>
<td>0.993635</td>
<td>2.538329</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1001.766</td>
<td>24</td>
<td>41.74023</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1002.299</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Rate Of RLR For Each Age Group /10000 Licensed driver

Figure 3.5: Number of Crashes Related to Red Light Running per 10,000 Licensed Drivers
3.5.3 DUI History

After analyzing the data for red light runners, it was found that the rate of red light runners drivers that involved with DUI (Driving under influence) were more likely to be young drivers according to the three years crash data for red light running crashes (see Figure 3.6).

Figure 3.6: Rate of DUI Red Light Runners 100,000 Licensed Drivers
3.6 Influence of the Environment on Red Light Running Crashes

3.6.1 Time of Day

The data analyzed showed that more red light running crashes (approximately 60%) occur during the p.m. time period. Approximately, 40% of the red lights running crashes occur during the a.m. time period. The percentage of crashes occurring during the a.m. time period and the percentage of crashes occurring the p.m. time period are presented in Figure 3.7.

![Figure 3.7: Time of the Day](image-url)
3.6.2 Day of Week

Slightly higher crashes related to red light running were observed occurring on Fridays and Saturdays compared to other days of the week. Figure 3.8 describes the number of crashes related to red light running per 1,000 million miles traveled for the different days of the week, which shows close results between the different days of the week.

![Figure 3.8: Day of the Week](image-url)
3.6.3 Type of Road

The total vehicle mile traveled (VMT) for the years 2002, 2003, and 2004 were obtained from the official website for FHWA as follows on Table 3.5. The number of related red light running crashes for urban and rural roads was obtained from the crash records by filtering the data with the code for urban roads (01) and (02) for rural roads. This data was used to normalize the frequency of red light running crashes for urban and rural roads to find the rate per 1000 vehicle mile traveled (VMT).

Table 3.5: Total Vehicle Mile Traveled and Red Light Running Crashes in Rural & Urban Roads (FHWA).

<table>
<thead>
<tr>
<th>RURAL-URBAN</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Light Running Crashes (Rural)</td>
<td>2241</td>
<td>2211</td>
<td>2283</td>
</tr>
<tr>
<td>Red Light Running Crashes (Urban)</td>
<td>4834</td>
<td>4722</td>
<td>4716</td>
</tr>
<tr>
<td>Total Vehicle Miles Traveled (Rural)</td>
<td>78272</td>
<td>68479</td>
<td>68852</td>
</tr>
<tr>
<td>Total Vehicle Miles Traveled (Urban)</td>
<td>41257</td>
<td>51896</td>
<td>50933</td>
</tr>
</tbody>
</table>
The average red light running crashes are higher on urban road compared to rural road. Rural related crashes are approximately one-third of the total crashes. The higher percentage of crashes related to red light running on urban road is probably due to the high number of signalized intersections in urban areas. Figure 3.9 shows the rate of crashes per 1,000 miles of road for urban and rural roads.

![Rate Of Rural and Urban Red Light Runner Crashes Per 1000 VMT](image)

Figure 3.9: Type of Road per 1,000 Mile
3.6.4 Weather

Most of the crashes related to red light running occurred during clear weather (more than 70%), which indicate that the influence of cloudy, rain, fog, and all other weather condition are insignificant. Figure 3.10 presents the percentage of crashes occurring at different weather conditions.

![Figure 3.10: Weather](image-url)
3.6.5 Crash Injury Severity

Injury levels related to any type of crash has different levels we can define them as follows:

1. No injury: Indicate there is no reason to believe any person received bodily harm from the crash. (23% of the red light related crashes have no injuries).

2. Possible injury: Indicates that no visible signs of injury but complaint of pain or momentary unconsciousness. (30% of the red light related crashes have possible injuries).

3. Non-incapacitating evident injury: Indicates any visible injuries such as bruises, abrasions, limping. (30% of the red light related crashes have non-incapacitating evident injuries).

4. Incapacitating injury: Indicates any visible injuries from the crash and person(s) had to be carried from the scene. (14% of the red light related crashes have incapacitating injuries).

5. Fatal injury: Indicates any injury sustained in a crash that result in death within 30 days. (1% of the red light related crashes have fatal injuries).

As shown in Figure 3.11 we can see that only 23% of crashes related to red light running have no injuries, and around 77% of the total crashed related to red light running has different level of injuries.
From Table 3.6, we can see that the red light running crashes in Florida for the years (2002, 2003 and 2004) accounts for more than 9000 injuries per year, and more than 60 death a year. The total amount of damage form crashes related to red light running is around 60 million dollars a year.

Table 3.6: Total Amount of Damage, Total Number of Injuries and Total Number of Fatalities From Red Light Running Crashes.

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Damage Amount</strong></td>
<td>$59,472,397</td>
<td>$58,071,485</td>
<td>$57,593,868</td>
</tr>
<tr>
<td><strong>Total Number of Injuries</strong></td>
<td>9,928</td>
<td>9,563</td>
<td>9,857</td>
</tr>
<tr>
<td><strong>Total Number of Fatalities</strong></td>
<td>62</td>
<td>73</td>
<td>78</td>
</tr>
</tbody>
</table>
3.7 Main Findings

After analyzing the data downloaded from the Department of Highway Safety and Motor Vehicle CD for Florida for three years (2002-2003-2004), the following findings are reported:

- 21,009 red light running related crashes occurred in Florida from 2002 to 2004.
- “Failed to Yield Right of Way” was found to be the highest second contributing cause the same results as the literature review.
- The rate of red light running crashes was approximately one crash per 2,000 licensed drivers.
- Over 90% of the crashes related to red light running involved through vehicles and less than 10% of the crashes related to red light running involved left turning vehicles.
- Approximately 65% of the crashes were angle crashes and that approximately 10% of the crashes were left turn collisions.
- People involved in red light running crashes are more likely to be males than females same results as the literature review.
- The younger age groups (16 to 20 and 20 to 25 year old) are more likely to be involved in a red light running related crash compared to other age groups. The older age groups accounted for a relatively small portion of red light running crashes same results as the literature review.
- Red light runners that involved DUI were more likely to be young same results as the literature review.
• More red light running crashes (approximately 60%) occur during the p.m. time period.

• Slightly higher crashes related to red light running were observed occurring on Fridays and Saturdays compared to other days of the week, however, the difference between the different days was not significant.

• The average red light running crashes are higher on urban road compared to rural road.

• Most of the crashes related to red light running occurred during clear weather (more than 70%), which indicate that the influence of cloudy, rain, fog, and all other weather condition are insignificant same results as the literature review.

• Only 23% of crashes related to red light running have no injuries, and around 77% of the total crashed related to red light running has different level of injuries.

• Red light running crashes in Florida for the years (2002, 2003 and 2004) accounts for more than 9000 injuries, and more than 60 death a year.

• The total amount of damage form crashes related to red light running in Florida is around 60 million dollars a year
CHAPTER 4 RELIABILITY OF CRASH DATA

4.1 Introduction

It is always hard to draw solid conclusions about the attributing cause of a collision. The crash databases themselves further contribute to this difficulty by not fully incorporating all of the potentially important information about the crash into the database. Consequently, researchers have sometimes turned to the actual hard copy crash reports filed by victims and/or law enforcement personnel who investigated the report.

Using this approach, the purpose of this part of the study is to analyze the actual hard copy crash reports and compare them with the data obtained from the database to investigate if errors often occur in how information on a red light running crash report is coded in the computerized crash database.

4.2 Data Sources

The data for this research was collected from the two following databases; the Crash Analysis Reporting System (CAR) and the Safety Electronic Document Management System (SEDMS).
4.2.1 The Crash Analysis Reporting System (CAR)

The information contained in the Crash Analysis Reporting system (CAR) has been compiled from information collected for the purpose of identifying, evaluating, or planning safety enhancements. This system and its products identify information used for the purpose of developing highway safety construction improvement projects, which may be implemented utilizing Federal-aid highway funds by the Florida Department of Transportation (CAR, 2006).

Figure 4.1 shows a sample of a report generated from the CAR system.

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**Figure 4.1: Sample of the Report from the CAR System**

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[Sample report from CAR system]

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39
The downloaded detailed data for the state roads in Florida from the CAR system contained more than 80 columns supplying information from the crash record for example, Crash report number, Crash date, Time of the accident, Day of the week, Distance, Mile post, County, Section number, Location mile post, Location node, Location distance, Route ID, Average daily traffic, Crash-level alcohol involved code, Fatality, Total amount of damage, Injury level, Number of people injured in the crash, Number of fatalities, First harmful event in the crash, Second harmful event, and other important information about the crash. Each of these columns has different codes to identify the characteristics of each crash; this will be explained in details for each page of the police report on the next section.

4.2.2 Safety Electronic Document Management System (SEDMS)

Another system created by the Florida Department of Transportation (FDOT) is named (SEDMS). The purpose of this system is to scan and import the crash reports into the Department Management System and to ensure those records are legible, properly indexed/archived, and retrievable. Each crash report consists of four pages, and the following section documents entries needed for these four pages.

4.2.2.1 Page 1

A detailed sample of the Page 1 is provided in Figure 4.2. Page 1 has the following fields:

1- Date of Crash: These three columns display the date of the crash.
2- Time of Crash: This displays the hour portion of the time of the crash.
3- Crash report number: This is an eight-digit number in the upper right hand corner of the report.

4- County Code: This is a two-digit code number for the county and the city in which the crash occurred.

5- City Code: This is the second portion of the County/City Code from the upper left corner of the first page of the crash report form, as coded by the officer.

6- Loc Dist: This is the distance from the intersecting roadway in miles.

7- Loc Dir: This is the direction from the intersecting roadway.

8- City or Town: This displays the City or Town where the crash occurred.

9- County: This displays the county where the crash occurred.

10- No. of Lanes: This is a one-digit field that displays the number of lanes for the roadway on which the crash occurred.

11- At the Intersection of (Street Road or Highway): This is a field that displays the first ten characters of the name of the roadway on which the crash occurred, as listed on the crash record.

12- From the Intersection of (Street Road or Highway): This field the closest the intersecting roadway.

13- Divided / Undivided: This single character that indicates whether the roadway on which the crash occurred is divided (“1”) or undivided (“2”), as indicated by the officer on the crash report form.

14- Drive Action: This is a field that shows the driver action
• “1” means Phantom.
• “2” means Hit and Run.
• “3” means Not Applicable.

15- Vehicle Type 1: This is the code, as entered by the officer, for the vehicle type for the first at-fault driver. If the record shows that no one is at-fault, this will be the code for driver #1. If the at-fault “driver” is a pedestrian then the value will be “77” (“Other”).

16- Vehicle Use 1: This is the code, as entered by the officer, for the vehicle use for the for the first at-fault driver. If the record shows that no one is at-fault, this will be the code for driver #1. If the at-fault “driver” is a pedestrian then the value will be “77” (“Other”). The officer records this on the first page of the crash report form.

17- Vehicle Traveling Direction 1: This is the one-character compass direction that gives the direction in which the vehicle was moving at the time of the crash. The value in this column will be for the first at-fault driver. If the record shows that no one is at-fault, this will be the code for driver #1.

18- Point of Impact 1: This is the code for Point of Impact for the first at-fault vehicle. If the record shows that no one is at-fault, this will be the code for vehicle #1. The officer enters this under each vehicle section on the crash report form.

19- Alcohol Involved: This is a crash-level alcohol/drugs involved code. The officer codes the alcohol involvement for each individual driver/ pedestrian involved in the crash. The data-load program generates this code based upon the individual alcohol/ drug codes submitted by the officer. They store crash-level codes and location information.

• “1” means Not Drinking or Using Drugs.
• “2” means Alcohol – Under Influence.
“3” means Drugs – Under Influence.
“4” means Alcohol and Drugs – Under Influence.
“5” means Had Been Drinking.
“6” means Pending Alcohol/Drug Test Results.

20- Race 1: This is the code, as entered by the officer, for the first at-fault driver race (white, black, Hispanic, or other).

21- Sex 1: This is the code, as entered by the officer, for the first at-fault driver sex (male or female).

22- Injury 1: This is the code, as entered by the officer, for the first at-fault driver injury (None, Possible, Non-Incapacitating, Incapacitating, Fatal (Within 30 Days), Non Traffic Fatality).

The second part of Page 1 contained the same information for Vehicle number 2 and the code information for the different fields.
Figure 4.2: Long Form Crash Report Sample – Page 1
4.2.2.2 Page 2

A detailed sample of the Page 2 is provided in Figure 4.3. The beginning of Page 2 contained the same information in Page 1 but for vehicle number 3. Page 2 has the additional following fields:

1- Contributing Cause 1: This is the code for Contributing Cause Driver/Pedestrian for the first at-fault driver/pedestrian or for driver/pedestrian #1

- “1” means No Improper Driving/Action.
- “2” means Careless Driving.
- “3” means Failed To Yield Right-of-Way.
- “4” means Improper Backing.
- “5” means Improper Lane Change.
- “6” means Improper Turn.
- “7” means Alcohol–Under Influence.
- “8” means Drugs – Under Influence.
- “9” means Alcohol and Drugs– Under Influence.
- “10” means Followed Too Closely.
- “11” means Disregarded Traffic Signal.
- “12” means Exceeded Safe Speed Limit.
- “13” means Disregarded Stop Sign.
- “14” means Failed To Maintain Equip/Vehicle.
- “15” means Improper Passing.
- “16” means Drove Left of Center.
- “17” means Exceeded Stated Speed Limit.
- “18” means Obstructing Traffic.
- “19” means Improper Load.
- “20” means Disregarded Other Traffic Control.
- “21” means Driving Wrong Side/Way.
- “22” means Fleeing Police.
- “23” means Vehicle Notified.
- “24” means Driver Distraction.
- “77” means All Other
2- Vehicle Defects 1: This is the code for Vehicle Defects for the first at-fault driver (No
Defects, Defective Brakes, Worn Tires, Defective Lights, Blowout, Steering Mech.,
Windshield Wipers, Vehicle Defect, or Other).

3- Vehicle Movement 1: This is the code, as entered by the officer, for the vehicle
movement for the first driver (Straight Ahead, Slowing, Stopped, Staled, Making Left
Turn, Braking, Making Right Turn, Changing Lanes, Entering/Leaving Parking Spaces,
Properly Parked, Improperly Parked, Missing U-Turn, Passing, Runway Vehicle, or All
Other).

4- Vehicle Special Functions: This is the code to show if there was a special function of the
vehicles (None, Farm, Police Pursuit, Recreational, Emergency Operation, Construction
or Maintenance).

5- Harmful Event 1: There are up to three harmful events per vehicle in the crash. This is the
first harmful event for the vehicle at fault in the crash, as coded by the officer on the
second page of the crash report form. If the records show that none of the drivers is at-
fault, this will be the first harmful event for the first vehicle or form section in the crash.

• “1” means Collision with MV in Transport (Rear End)
• “2” means Collision with MV in Transport (Head-on)
• “3” means Collision with MV in Transport (Angle)
• “4” means Collision with MV in Transport (Left Turn)
• “5” means Collision with MV in Transport (Right Turn)
• “6” means Collision with MV in Transport (Sideswipe)
• “7” means Collision with MV in Transport (Backed Into)
• “8” means Collision with Parked Car
• “9” means Collision with MV on Other Roadway
• “10” means Collision with Pedestrian
• “11” means Collision with Bicycle
• “12” means Collision with Bicycle (Bike Lane)
• “13” means Collision with Mopped
• “14” means Collision with Train
• “15” means Collision with Animal
• “16” means MV Hit Sign/Sign Post
• “17” means MV Hit Utility Pole/Light Pole
• “18” means MV Hit Guardrail
• “19” means MV Hit Fence
• “20” means MV Hit Concrete Barrier Wall
• “21” means MV Hit Bridge/Pier/Abutment/Rail
• “22” means MV Hit Tree/Shrubbery
• “23” means Collision with Construction Barricade Sign
• “24” means Collision with Traffic Gate
• “25” means Collision with Crash Barrier
• “26” means Collision with Fixed Object Above Road
• “27” means MV Hit Other Fixed Object
• “28” means Collision with Moveable Object on Road
• “29” means MV Ran into Ditch/Culvert
• “30” means Ran Off Road
• “31” means Overturned
• “32” means Occupant Fell From Vehicle
• “33” means Tractor
• “34” means Fire
• “35” means Explosion
• “36” means Downhill Runaway
• “37” means Cargo Loss
• “38” means Separation of Units
• “39” means Median Crossover
• “77” means All Other

6- Lighting: This is the Lighting Conditions code as entered by the officer on the second page of the crash report form (Daylight, Dusk, Dawn, Dark Street Light, Dark No Street Light, and Unknown).

7- Road Surface: This is the Road Surface Conditions code as entered by the officer on the second page of the crash report form (Dry, Wet, Slippery, Icy, and All Other).

8- Weather: This is the Weather Conditions code as entered by the officer on the second page of the crash report form (Clear, Cloudy, Rain, Fog, and All Other).
9- Road Conditions: This is the first Road Conditions at Time of Crash code as entered by the officer on the second page of the crash report form.

10- Traffic Control: This is the first Traffic Control code as entered by the officer on the second page of the crash report form (No Control, Special Speed Zone, Speed Control Sign, School Zone, Traffic Signal, Stop Sign, Yield Sign, Flashing Light, Railroad Signal, Officer/Guard/Flagman, Posted No U-Turn, No Passing Zone, and All Other).

11- Site Location: This value is coded by the office (Not At Intersection, At Intersection, Influenced By Intersection, Driveway Access, Railroad, Bridge, Entrance Ramp, Exit Ramp, Parking Lot Public, Parking Lot Private, Private Property, Toll Booth, Public Bus Stop Zone, and All Others)
Figure 4.3: Long Form Crash Report Sample – Page 2
4.2.2.3 Page 3

A detailed sample of the Page 3 is provided in Figure 4.4. The first section of Page 3 contained the Date of Crash, County/City Code, and Report Number. The second section of Page 3 was the narrative explaining how the crash occurred exactly. This part is very important since it can help determining the exact contributing cause of the crash. The information in this section depends on the amount of information entered by the officer.

The third section in Page 3 was to enter the information related to the passengers in every vehicle including the passenger name, current address, city and state, zip code, date of birth, race, sex, location, injury type, and if he/she was ejected or not.

The fourth section listed the violators’ details including the vehicle, name of violator, Florida statute number, charge, and citation number. The last section included the information related to any witnesses for the crash including the witness name, current address, city, state, and zip code. Finally, the information of the investigator including badge number, department, date of report, and number of pictures were listed at the end of Page 3.
Vehicle 1 (V-1) was traveling West on State Road 50 in the left turn lane. Vehicle 2 (V-2) was traveling East on State Road 50 in the right lane. The driver of V-1 claims he might have run a red light. The driver of V-2 claims to have had a Green light. Both vehicles were moved prior to my arrival. Due to conflicting information no citations were issued.
4.2.2.4 Page 4

A detailed sample of the Page 3 is provided in Figure 4.5. This page provided a diagram for the intersection including a north arrow to show the directions, lanes, median, striping, vehicle 1, vehicle 2, vehicle 3 if applicable, pedestrian if involved in the crash, and bicycle if involved in the crash. The diagram also describes the location of every vehicle including the direction, movement, and point of contact. This page is needed to determine the real cause of a crash especially if the law enforcement officer made an error in recording the correct code previous page.

According to results we obtained from the description of the crash on this page, we compared the data that we have from the long form report with that output data from the CAR system to get the real number of red light related crashes
4.3 Study Site Selection

Data were collected for five sites. All sites are located in Orange County, Florida. The sites have been chosen since these sites are identified with a high crash rate. The geometric characteristics for the five sites such as number of lanes, the width of lanes, and the median type are provided in Table 4.1. The signal timings and the left turn treatment are provided in Table 4.2. The intersections are as follows:

Table 4.1: Geometric Characteristics of the Studied Sites

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>No. &amp; width of Through Lane(Feet)</th>
<th>No. &amp; width of Right turn Lane</th>
<th>No. &amp; width of Left turn Lane</th>
<th>Median Type*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB</td>
<td>WB</td>
<td>NB</td>
<td>SB</td>
</tr>
<tr>
<td>SR 50 &amp; SR 434</td>
<td>2(12)</td>
<td>2(12)</td>
<td>3(12)</td>
<td>3(12)</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee Rd</td>
<td>2(12)</td>
<td>2(12)</td>
<td>2(12)</td>
<td>2(12)</td>
</tr>
<tr>
<td>US 17-92 &amp; Sand lake Rd</td>
<td>2(12)</td>
<td>3(12)</td>
<td>3(12)</td>
<td>3(12)</td>
</tr>
<tr>
<td>US 17-92 &amp; Taft Vineland Rd</td>
<td>2(11)</td>
<td>2(11)</td>
<td>3(12)</td>
<td>3(12)</td>
</tr>
<tr>
<td>US 17-92 &amp; Holden Ave</td>
<td>2(12)</td>
<td>2(12)</td>
<td>3(11)</td>
<td>3(11)</td>
</tr>
</tbody>
</table>

*Rm=Raised Median

Table 4.2: Traffic Signal Characteristics of the Studied Sites

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Left-turn Protection*</th>
<th>Speed Limit (mph)</th>
<th>All Red Time (seconds)</th>
<th>Yellow Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB</td>
<td>WB</td>
<td>NB</td>
<td>SB</td>
</tr>
<tr>
<td>SR 50 &amp; SR 434</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee Rd</td>
<td>P</td>
<td>P</td>
<td>P/P</td>
<td>P/P</td>
</tr>
<tr>
<td>US 17-92 &amp; Sand lake Rd</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>US 17-92 &amp; Taft Vineland Rd</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
</tr>
<tr>
<td>US 17-92 &amp; Holden Ave</td>
<td>P/P</td>
<td>P/P</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>

*P=Protected      *P/P=Protected Permitted
4.3.1 SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail)

This is an intersection of two major arterials to the south and west of the University of Central Florida. This intersection serves much of the university-bound traffic, as well as a large amount of non-university related traffic. This is a very high volume intersection, has a large area, and has high approach speeds. Pedestrian and bicycle activity at this intersection is negligible. A plan of this intersection is shown in Figure 4.6.

Figure 4.6: SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail)
The intersection is signalized with protected-only left turn phases on SR 50 followed by the through movement phases, and protected-only left turn phases on SR 434 followed by the through phases.

4.3.2 SR 50 (West Colonial Drive) and North Hiawassee Road

This is an intersection of two major arterials, where SR 50 runs east/west and Hiawassee Road runs north/south. This intersection serves high traffic volumes. All site-specific characteristics are given in Table 4.1 and Table 4.2. A plan of this intersection is shown in Figure 4.7.
The intersection is signalized with protected-only left turn phases on SR 50 followed by the through movement phases, and a leading left turn arrow for southbound North Hiawassee Road followed by the through phases then a lagging left turn arrow for northbound North Hiawassee Road.

4.3.3 US 17-92 (Orange Blossom Trail) and Sand Lake Road

This is an intersection of two major arterials, where US 17-92 runs north south and Sand Lake Road runs east west. This intersection serves high traffic volumes. All site-specific characteristics are given in Table 4.1 and Table 4.2. A plan of this intersection is shown in Figure 4.8.
Figure 4.8: US 17-92 (Orange Blossom Trail) and Sand Lake Road
The intersection is signalized with protected-only left turn phases on US 17-92 followed by the through movement phases, and protected-only left turn phases on Sand Lake Road followed by the through phases.

4.3.4 US 17-92 (Orange Blossom Trail) and Taft Vineland Road

This is an intersection of two major arterials, US 17-92 runs north south and Taft Vineland Road runs east west. This intersection serves high traffic volumes. All site-specific characteristics are given in Table 4.1 and Table 4.2. A plan of this intersection is shown in Figure 4.9.
The intersection is signalized with protected-only left turn phases on US 17-92 followed by the through movement phases, and protected-permitted left turn phases on Taft Vineland Lake Road followed by the through phases.

4.3.5 US 17-92 (Orange Blossom Trail) and West Holden Avenue

This is an intersection of two major arterials, where US 17-92 runs north south and West Holden Avenue runs east west. This intersection serves high traffic volumes. All site-specific characteristics are given in Table 4.1 and Table 4.2. A photo of this intersection is shown in Figure 4.10.

Figure 4.10: US 17-92 (Orange Blossom Trail) and West Holden Avenue
The intersection is signalized with protected-only left turn phases on US 17-92 followed by the through movement phases, and protected-permitted left turn phases on West Holden Avenue followed by the through phases.

4.4 Data Analysis

The data in the CAR database was accessed and it was found that there were total of 862 crashes related to the five studied intersections in the period of five years studies (from 2002 to 2006). A summary of the data is presented in Table 4.3

<table>
<thead>
<tr>
<th>Intersection</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 50 and SR 434</td>
<td>28</td>
<td>25</td>
<td>49</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>SR 50 and N. Hiawassee Rd</td>
<td>25</td>
<td>26</td>
<td>52</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>US 17-92 and Sand Lake Rd</td>
<td>13</td>
<td>32</td>
<td>29</td>
<td>36</td>
<td>32</td>
</tr>
<tr>
<td>US 17-92 and Taft Vineland Rd</td>
<td>39</td>
<td>41</td>
<td>37</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>US 17-92 and W. Holden Ave</td>
<td>20</td>
<td>23</td>
<td>29</td>
<td>42</td>
<td>37</td>
</tr>
<tr>
<td>Total (862 crashes)</td>
<td>125</td>
<td>147</td>
<td>196</td>
<td>200</td>
<td>194</td>
</tr>
</tbody>
</table>

The filter option was utilized in the database to obtain the crashes caused by red light running. Out of the 862 total crashes in the five intersections, it was found that there were 28 crashes coded as ”disregard traffic signal”. The results of the filter are shown in Table 4.4.
The SEDMS database was accessed and the 862 crashes long forms were downloaded. The long form crashes were analyzed to determine and identify the crashes related to red light running. After reviewing the reports and comparing the code information, narrative, crash diagram, it was found there were 31 additional crashes related to red light running forming a total of 59 crashes related to red light running (see Table 4.5). The additional crashes raised the percentage of related red light running crashes from 3.25% to 7.31%. It should be noted that this results differs from the estimate of Mohamedshah et al. (2000), which was 16 to 20%.

Table 4.5 Red Light Running Crash Frequency for Each Intersection from the Long Form Reports

<table>
<thead>
<tr>
<th>Intersection</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 50 and SR 434</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>SR 50 and N. Hiawassee Rd</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>US 17-92 and Sand Lake Rd</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>US 17-92 and Taft Vineland Rd</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>US 17-92 and W. Holden Ave</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total (59 crashes)</td>
<td>11</td>
<td>9</td>
<td>5</td>
<td>14</td>
<td>20</td>
</tr>
</tbody>
</table>
The inspection of the additional 31 crash reports indicated that the contributing causes were careless driving (7 collisions), failed to yield right of way (10 collisions), Improper turn (3 collision), and did not specify (8 collisions) see Table 4.6).

Table 4.6 Red Light Running Crashes Contributing Cause from the Long Form Reports

<table>
<thead>
<tr>
<th>Contributing cause</th>
<th>RLR Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No improper driving</td>
<td>1</td>
</tr>
<tr>
<td>Careless Driving</td>
<td>7</td>
</tr>
<tr>
<td>Failed to yield right of way</td>
<td>10</td>
</tr>
<tr>
<td>Improper turn</td>
<td>3</td>
</tr>
<tr>
<td>Exceeded safe speed limit</td>
<td>1</td>
</tr>
<tr>
<td>Disregard other traffic control</td>
<td>1</td>
</tr>
<tr>
<td>All other</td>
<td>7</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
</tr>
</tbody>
</table>

4.4.1 SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail)

The first intersection had an additional four crashes. The first additional crash (dated 4/4/2003) had the first contributing cause as Improper Turn but the actual contributing cause was running red light by a left turning movement. The second additional crash (dated 3/27/04) had the first contributing cause as Exceeded Safe Speed Limit but the actual contributing cause was failing to stop at the intersection and running red light. The third additional crash (dated 5/26/05) had no contributing cause coded at all and the actual contributing cause was failure to stop at a red light then running a red light. The fourth additional crash (dated 5/1/06) was coded as No
Improper Driver since the no fault driver was coded first although the second driver had Disregarded Traffic Signal as a contributing cause.

4.4.2 SR 50 (West Colonial Drive) and North Hiawassee Road

The second intersection had an additional seven crashes. The first crash (dated 3/24/02) involved a left turning vehicle with a through vehicle. Both vehicles claimed to have a green arrow and a solid green respectively and the contributing cause was coded as All Other. The second and the third crashes (dated 10/1/03 and 11/26/05) occurred when a vehicle failed to stop and entered the intersection during red light. This crash was coded as careless driving. The fourth crash dated (8/25/05) was a through vehicle running red light and coded as Failed to Yield Right-of-Way. The fifth and sixth crashes dated (7/30/06 and 9/18/06) involved a through vehicle running red light and coded as Careless Driving. The seventh crash dated (10/24/06) involved a through vehicle running red light and coded as Failed to Yield Right-of-Way.

4.4.3 US 17-92 (Orange Blossom Trail) and Sand Lake Road

The third intersection had an additional ten crashes. The first crash (dated 5/18/02) involved a left turning vehicle running red light and coded as Careless Driving. The second crash (dated 5/24/02) involved a left turning vehicle running red light and coded as Failed to Yield Right-of-Way. The third crash (dated 2/19/02) involved a through vehicle running red light and coded as Failed to Yield Right-of-Way. The fourth crash (dated 5/16/02) involved a left turning vehicle with a through vehicle. Both vehicles claimed to have a green arrow and a solid green respectively and the contributing cause was coded as All Other. The fifth crash (dated 11/27/04)
involved a left turning vehicle running red light and coded as Failed to Yield Right-of-Way. The sixth, ninth, and tenth crashes (dated 11/6/05, 3/9/06, and 8/5/06) involved a two opposing through vehicles. Both vehicles claimed to have a green arrow and a solid green respectively and the contributing cause was coded as All Other. The seventh crash (dated 5/22/05) involved a left turning vehicle running red light and coded as Failed to Yield Right-of-Way. The eighth crash (dated 2/13/06) involved a through vehicle running red light and mistakenly coded as Disregarded Other Traffic Control.

4.4.4 US 17-92 (Orange Blossom Trail) and Taft Vineland Road

The fourth intersection had an additional five crashes. The first and second crashes (dated 9/9/02 and 7/17/03) involved a left turning vehicle with a through vehicle. Both vehicles claimed to have a green arrow and a solid green respectively and the contributing cause was coded as All Other. The third crash (dated 2/25/04) involved a through vehicle running red light and coded as Careless Driving. The fourth crash (dated 11/1/05) involved a left turning vehicle running red light and coded as Improper Turn. The fifth crash (dated 1/31/06) involved a left turning vehicle running red light and coded as Careless Driving.

4.4.5 US 17-92 (Orange Blossom Trail) and West Holden Avenue

The fifth intersection had an additional 6 crashes. The first crash (dated 11/7/02) involved a left turning vehicle running red light and coded as Failed to Yield Right-of-Way. The second crash (7/17/03) involved a left turning vehicle with a through vehicle. Both vehicles claimed to have a green arrow and a solid green respectively and the contributing cause was coded as All
Other. The third crash (dated 7/3/04) involved a vehicle that braked hard to avoid running the red light but stopping inside the intersection causing a rear end crash with the vehicle behind him. This crash was coded as All Other. The fourth crash (dated 12/9/05) involved a left turning vehicle running red light and coded as Improper Turn. The fifth crash (dated 3/4/06) involved a through vehicle running red light and coded as Failed to Yield Right-of-Way. The fifth crash (dated 9/22/06) involved a through vehicle running red light and coded as Careless Driving.

4.5 Comparison between the CAR System and the Long Form Crash Reports

The above analysis shows that the percentage of crashes related to red light running from the CAR system (Disregarded Traffic Signal as first contributing cause) was not the same as the percentage of crashes related to red light running from the long form crash report forms. The findings presented in this research imply that the red light running crashes are being underreported if only the CAR system is utilized. To obtain real number of red light running crashes, the long forms crash reports should be analyzed.

It can be assumed that most the right angle and left turning crash types with disregarded traffic signal as a contributing cause fairly represent crashes resulting from red light running violations at signalized intersections. However, not all red light running crashes are reported as “disregarded traffic signal”. Therefore, representing red light running crashes only through “disregard traffic signal” noted reports would underestimate the extent of red light running effects at a given intersection. Therefore, as part of the previous analysis, all long form crash
reports for 862 crashes were reviewed to determine the actual number of crashes related to red light running per movement using the 2002-2006 data for five intersections.

The percentage of red light running crashes reported as “Disregard Traffic Signal” in the CAR system was 3.25%. These crashes had “Disregarded Traffic Signal” as the first contributing cause. Based on the detailed analysis of the long form crash reports, it was found that the actual percentage of red light running was 7.31%, which is more than double the number of crashes reported by the CAR system.

The previous results show the importance of standardizing the format and coding process for the long form crashes by the police officers to help identify the real pattern at the studied location.

Figure 4.11 depicts the percentage of the different contributing causes listed for the five studied intersections. Other contributing causes included No Improper Driving, Careless Driving, Failed to Yield Right of Way, Improper Turn, Exceeded Safe Speed Limit, Disregard Other Traffic Control, All Other, and Unknown. Failed to Yield Right of Way was found to be the highest listed contributing cause instead of Red Light Running (Disregard Traffic Signal) with 30.30% followed by Careless and All Other with 24.24% each. Improper Turn accounted for 9.09%. The remaining contributing causes (No Improper Driving, Exceeded Safe Speed Limit, Disregard Other Traffic Control, and Unknown) accounted for 3.03% each.
Figure 4.11: Different Contributing Causes

The frequent problems founded in coding the red light running crashes were:

4.5.1 Failed to Yield Right-of-Way

Failed to Yield Right-of-Way was found to be the highest contributing cause (30.30%). In some cases, vehicles failed to stop and entered the intersection running the red light. These crashes were coded as Failed to Yield Right-of-Way.
4.5.2 All Other

All other was found to be the second highest contributing cause (24.24%). When there is conflict where both left turning vehicle and through vehicle claimed to have a green arrow and a solid green respectively, the contributing cause is coded as All Other.

4.5.3 Careless Driving

Careless Driving was found to be the second highest contributing cause (24.24%) with All Other. In some cases, the crash was coded as Careless Driving. Going through the narrative, the main contributing cause was running red light.

4.5.4 Improper Turn

Improper Turn was found to be the third highest contributing cause (9.04%). In some cases, the left turning vehicles running red light were coded as Improper Turn. Going through the narrative, the main contributing cause was running red light.

4.5.5 No Improper Driving

In some cases, the red light running crashes were coded as Improper Driving when there is a conflict between the two drivers.

4.5.6 Disregard Other Traffic Signal

Some of the red light runner crashes were coded mistakenly as Disregard Other Traffic Signal instead of Disregard Traffic Signal.
4.5.7 Other Coding Problems

4.5.7.1 Not Filling the Contributing Cause

In some crashes, the contributing cause was not filled at all but going through the narrative and the diagram the crash is clearly a red light running related crash.

4.5.7.2 Coding the Driver at Fault as Second Driver

The no fault driver was coded as the first driver although the second driver had Disregarded Traffic Signal as a contributing cause. In the CAR system, the contributing cause is coded as the contributing cause of the first driver.

4.5.7.3 Having More Than One Contributing Cause

In some cases, there is more than one contributing cause and running red light is the second contributing cause. In this case, the crash is coded in the CAR system using the first contributing cause.

4.5.7.4 Having More Than One Contributing Cause

In some cases, there is more than one contributing cause and running red light is the second contributing cause. In this case, the crash is coded in the CAR system using the first contributing cause.
4.6 Comparison between Type of Crashes (Left Turn Against Right Angle)

Figure 4.12 shows the number of left turn collisions and the number of angle collisions per intersection. A left turn collision is defined as a collision between a left turning vehicle and a through vehicle from the opposing direction. An angle collision is defined as collision between a through or left turning vehicle and a through vehicle from the intersecting direction. The results were mixed. It was found that left turn collisions were higher than the angle collisions (at the intersections of Orange Blossom Trail and Sand Lake Road and at the intersection Alafaya Trail and Colonial Drive) and vice versa at the other three intersections. A more in depth analysis of the signal timing, phasing scheme might explain this inconclusive finding.

![Comparison Between Type of Crashes (Left Against Angle)](image)

Figure 4.12: Red Light Running Crashes Per Type of Crash
4.7 Comparison Between Type of Movements (Left Turning Against Through)

Figure 4.13 shows the number of left turning movement related collisions and the number of through movement related collisions per intersection for the five studied intersections. As expected, it was found that more through related collisions than left turn related collisions at all five intersections. These results were expected due to a higher through volume compared to left turn volumes.

Figure 4.13: Red Light Running Related Crashes Per Type of Crash
4.8 Involvement of Left Turn and Through Movement in Red Light Running Crashes

Figure 4.14 shows the percentage of left turning movement related collisions and the percentage of through movement related collisions per intersection for the five studied intersections, it was found that more left turn related collisions were higher than through related collisions at four intersections. Therefore, We can conclude that left turn crashes had high percentage of involvements in red light running crashes for the four studied intersections.

![Red Light Running Crashes % From Left Turn And Through]

Figure 4.14: Red Light Running Related Crashes Per Type of Crash
It should be noted that from observing the police reports for the red light running crashes it was found that there were some mistakes in reporting the type of crashes in the part of first harmful event, they coded the left turn crash as angle crash shown in Figure 4.17 and Figure 4.16.

After observing the data from the CAR system and comparing it to the observed data from the police report, we can conclude that there were errors in identifying the type of red light running crashes in the section of first harmful event.
Figure 4.15: Example Of The Error In Coding The Red Light Running Type Of Crash.
Figure 4.16: Coding The Left Turn Red Light Running Crash As Angle Crash.
4.9 Reliability of Crash Data in Large Scale

Based on the analysis documented in the previous sections, a difference was found between the data extracted from the CAR system using the first contribution cause as disregard traffic signal and the data analyzed from the long form. The analysis conducted for the five intersections yield an error of around 100% understanding the number of Red Light Running Crashes.

It was decided to expand this process for a larger sample as described on the next section.

4.10 Data Collection

The year 2004 crash data was chosen for this analysis since it was the latest year of crash data. 156,000 crashes occurred in year 2004 in Florida. It was decided to use a one percent of the 2004 crashes in this analysis. In order to select a random sample of 1,600 long form crash reports, the SAS software was utilized. The purpose of using the SAS software was to draw a random sample from the data.

4.11 Analysis

The percentage of red light running crashes reported in the CAR system for the random sample of 1,600 crashes that occurred in 2004 was 3.13%. It should be noted that this percentage is so close to the percentage obtained from the five intersections sample (3.25%). These crashes
had “Disregarded Traffic Signal” as the contributing cause. Based on the detailed analysis of the long form crash reports, it was found that the actual percentage of red light running was 5.63%. It should be noted that this percentage is lower that the percentage obtained from the five intersections sample (7.31%).

The previous results shows the importance of standardizing the format and coding process for the long form crashes by the police officers to help identify the real pattern at the studied location.

Figure 4.17 depicts the percentage of the different contributing causes listed for the random sample. Other contributing causes included No Improper Driving, Careless Driving, Failed to Yield Right of Way, Improper Turn, Failed to Maintain Equipment, Disregard Other Traffic Control, Fleeing Police, All Other, and Unknown. All Other was found to be the highest listed contributing cause instead of Red Light Running (Disregard Traffic Signal) with 25% followed by Failed to Yield Right of Way with 22.50% and Careless Driving with 20%. No Improper Driving accounted for 15% and Improper Turn for 7.5%. The remaining contributing causes (Failed to Maintain Equipments, Disregard Other Traffic Control, Fleeing Police, and Unknown) accounted for 2.5% each.
4.11.1 All Other

All other was found to be the First highest contributing cause (25%). When there is conflict where both left turning vehicle and through vehicle claimed to have a green arrow and a solid green respectively, the contributing cause is coded as All Other.

4.11.2 Failed to Yield Right-of-Way

Failed to Yield Right-of-Way was found to be the highest contributing cause (22.5%). In some cases, vehicles failed to stop and entered the intersection running the red light. These crashes were coded as Failed to Yield Right-of-Way.
4.11.3 Careless Driving

Careless Driving was found to be the second highest contributing cause (20%) with All Other. In some cases, the crash was coded as Careless Driving. Going through the narrative, the main contributing cause was running red light.

4.11.4 No Improper Driving

In some cases, the red light running crashes were coded as Improper Driving (15%) when there is a conflict between the two drivers.

4.11.5 Improper Turn

Improper Turn was found to be the third highest contributing cause (7.5%). In some cases, the left turning vehicles running red light were coded as Improper Turn. Going through the narrative, the main contributing cause was running red light.

4.11.6 Disregard Other Traffic Signal

Some of the red light runner crashes were coded mistakenly as Disregard Other Traffic Signal (2.5%) instead of Disregard Traffic Signal.

Upon comparison Figure 4.11 and Figure 4.17, it appears that both analyses agreed that Careless driving, Failed to yield right of the way, Improper turn, and all other were the highest type of error in data recording, however when considering a large sample an additional cause appeared which is No improper driving.
CHAPTER 5 CORRELATION BETWEEN RED LIGHT RUNNING VIOLATIONS AND RED LIGHT RUNNING CRASHES

5.1 Correlation between Red Light Running Violations And Red Light Running Crashes

One of the goals of this study was to attempt to graphically examine the correlation between red light running violations and red light running crashes. The five sites studied were equipped with red light running cameras to record the number of violations in specific period. Crash records for the five selected intersections were analyzed as part of a previous task.

It should be noted that these five intersections were selected by Orange County to be equipped with red light running cameras because they had the highest crash rate in the county. The crash rate per number of vehicles crossing the intersection in million were obtained from the Orlando Urban Area 2004 Crash Surveillance Report and are shown in Table 5.1

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Crash Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBT &amp; Sand lake</td>
<td>1.45</td>
</tr>
<tr>
<td>OBT &amp; Taft Vinland</td>
<td>1.99</td>
</tr>
<tr>
<td>Alafaya &amp; Colonial</td>
<td>1.35</td>
</tr>
<tr>
<td>OBT &amp; Holden Ave</td>
<td>2.53</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee</td>
<td>1.71</td>
</tr>
</tbody>
</table>

*Crash rate is the total number of accidents per one million-vehicle crossing.
The violations were obtained for the five intersections for a three-months period during the year 2006-2007. A sample of the violations is provided in Table 5.2. The violations data included the time and date of violation, number of violations observed, which zone the camera cover direction, the approach, the movement (left turning or through), and the intersection name. As a starting point, we carefully examined the data for consistency and possible errors. It was observed that the red light running camera recorded unreasonable number of violations repeated for several periods. These observations were removed from further analyses.
Table 5.2: Red Light Running Violations Data Sample

<table>
<thead>
<tr>
<th>Interval</th>
<th>Count</th>
<th>Zone</th>
<th>Date</th>
<th>Module</th>
<th>Direction</th>
<th>IntersectionName</th>
</tr>
</thead>
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<tr>
<td>From 2:50 PM to 3:50 PM</td>
<td>4</td>
<td></td>
<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
<tr>
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<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
<tr>
<td>From 4:50 PM to 5:50 PM</td>
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<tr>
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<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
<tr>
<td>From 6:50 PM to 7:50 PM</td>
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<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
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<tr>
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<td></td>
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<tr>
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<tr>
<td>From 9:50 PM to 10:50 PM</td>
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<tr>
<td>From 10:50 PM to 11:50 PM</td>
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<td>Module 1</td>
<td>NBLT</td>
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<td>NBLT</td>
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<td>OBT and TaftVineland</td>
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<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
<tr>
<td>From 2:50 AM to 3:50 AM</td>
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<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
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<tr>
<td>From 3:50 AM to 4:50 AM</td>
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<td>OBT and TaftVineland</td>
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<tr>
<td>From 6:50 AM to 7:50 AM</td>
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<td>NBLT</td>
<td>OBT and TaftVineland</td>
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<tr>
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<td>OBT and TaftVineland</td>
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<tr>
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<td>11/21/2006</td>
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<td>OBT and TaftVineland</td>
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<tr>
<td>From 9:50 AM to 10:50 AM</td>
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<td></td>
<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
<tr>
<td>From 10:50 AM to 11:50 AM</td>
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<td></td>
<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
<tr>
<td>From 11:50 AM to 12:50 PM</td>
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<td></td>
<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
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<tr>
<td>From 12:50 PM to 1:50 PM</td>
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<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
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<td></td>
<td>11/21/2006</td>
<td>Module 1</td>
<td>NBLT</td>
<td>OBT and TaftVineland</td>
</tr>
</tbody>
</table>
After tabulating the total violations for each approach as shown in Table 5.3, and the total recorded hours for each approach as shown in Table 5.4 we calculate the average rate of violations for each approach per hour. The results are as shown in Table 5.5.

For the five intersections, we summarized the red light running crashes for each approach as shown in Table 5.6, to find if there is correlations between the average number of violations per hour and the number of red light running crashes for each approach.

Table 5.3: Total Violations Per Lane Type

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Total No. of Through Lane Violations</th>
<th>Total No. of Left-turn Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB</td>
<td>WB</td>
</tr>
<tr>
<td>OBT &amp; Sand lake</td>
<td>15237</td>
<td>8516</td>
</tr>
<tr>
<td>OBT &amp; Taft Vinland</td>
<td>7694</td>
<td>17945</td>
</tr>
<tr>
<td>Alafaya &amp; Colonial</td>
<td>5884</td>
<td>9643</td>
</tr>
<tr>
<td>OBT &amp; Holden Ave</td>
<td>5105</td>
<td>5813</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee</td>
<td>4684</td>
<td>6151</td>
</tr>
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</table>

Table 5.4: Total Recorded Hours Of Violations Per Lane Type

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>No. Recorded Hours For Through Lane Violations</th>
<th>No. Recorded Hours For Left-turn Violations</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>EB</td>
<td>WB</td>
</tr>
<tr>
<td>OBT &amp; Sand lake</td>
<td>4556</td>
<td>4665</td>
</tr>
<tr>
<td>OBT &amp; Taft Vinland</td>
<td>1556</td>
<td>1557</td>
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<tr>
<td>Alafaya &amp; Colonial</td>
<td>3410</td>
<td>886</td>
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<tr>
<td>OBT &amp; Holden Ave</td>
<td>4146</td>
<td>4172</td>
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<tr>
<td>SR 50 &amp; Hiawassee</td>
<td>40688</td>
<td>34504</td>
</tr>
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</table>
Table 5.5: Average Violations Per Hour Per Lane Type

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Through Lane Violations/h</th>
<th>Left-turn Violations/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB</td>
<td>WB</td>
</tr>
<tr>
<td>OBT &amp; Sand lake</td>
<td>3.34</td>
<td>1.83</td>
</tr>
<tr>
<td>OBT &amp; Taft Vinland</td>
<td>4.94</td>
<td>11.53</td>
</tr>
<tr>
<td>Alafaya &amp; Colonial</td>
<td>1.73</td>
<td>10.88</td>
</tr>
<tr>
<td>OBT &amp; Holden Ave</td>
<td>1.23</td>
<td>1.39</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee</td>
<td>0.50</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Table 5.6: Red Light Running Crashes Per Lane Type

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Through Lane Crashes/5 Years</th>
<th>Left-turn Crashes/5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB</td>
<td>WB</td>
</tr>
<tr>
<td>OBT &amp; Sand lake</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>OBT &amp; Taft Vinland</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Alafaya &amp; Colonial</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>OBT &amp; Holden Ave</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

5.1.1 SR 50 (East Colonial Drive) and SR 434 (Alafaya Trail)

At the first intersection, the highest average violations occurred for the westbound left turning movement and for the through movement (10.88 and 10.33 average violations per hour respectively). The lowest average violations occurred for the eastbound left turning movement and the northbound left turning movement (1.73 and 1.70 average violations per hour respectively).
As far as the number of crashes, the highest number of crashes occurred for the southbound through movement and for the westbound through movement (4 and 3 respectively). The lowest number of crashes occurred for the northbound through movement, the northbound left turning movement, and the southbound left turning movement (no crashes).

![Correlations Between Red Light Crashes & Red Light Violations (Alafaya & Colonial)](image)

Figure 5.1: Intersection 1 - Correlation between Red Light Running Violations and Red Running Crashes

After plotting the data for the red light running crashes and the average number of violations per hour for each approach as shown in Figure 5.1, we can see that there is high rate of violations with low number of crashes and high crashes with low rate of violations. We checked the correlation factor between the average red light running violations per hour and the frequency of red light running crashes ($R^2 = 0.119478$), Therefore we can conclude that there is no reason
to believe that a correlation between the red light running crashes and average violation per hour exists at the intersection of SR 50 and Alafaya Trail.

5.1.2 SR 50 (West Colonial Drive) and North Hiawassee Road

At the second intersection, the highest average violations occurred for the northbound through movement, northbound left turning movement, and the southbound left turning volume (1.48, 1.77, and 1.47 average violations per hour respectively). The lowest average violations occurred for the eastbound through movement and the westbound through movement (0.50 and 0.71 average violations per hour respectively).

As far as the number of crashes, the highest number of crashes occurred for the southbound through movement and for the eastbound through movement (4 and 3 respectively). The lowest number of crashes occurred for the westbound left turning movement, the northbound through movement, the northbound left turning movement, and the southbound left turning movement (one crash).
Correlations between Red Light Running Crashes &
Red Light Violations (SR 50 & Hiawassee)

Figure 5.2: Intersection 2 - Correlation Between Red Light running Violations And Red Light Running Crashes.

After plotting the data for the red light running crashes and the average number of violations per hour for each approach shown in Figure 5.2, we can see that there is high rate of violations with low number of crashes and high crashes with low rate of violations. We checked the correlation factor between the average red light running violations per hour and the frequency of red light running crashes \( (R^2 = 0.08164) \), Therefore we can conclude that there is no correlation between the red light running crashes and average violation per hour at the intersection of SR 50 and Hiawassee Road.

5.1.3 US 17-92 (Orange Blossom Trail) and Sand Lake Road

At the third intersection, the highest average violations occurred for the southbound left turning movement, the northbound left turning movement, and the westbound left turning...
movement (9.43, 7.85, and 7.64 average violations per hour respectively). The lowest average violations occurred for the westbound left turning movement (1.83 average violations per hour).

As far as the number of crashes, the highest number of crashes occurred for the westbound left turning movement (4 crashes). The lowest number of crashes occurred for the southbound left turning movement, the eastbound left turning movement, and the northbound left turning movement (no crashes, 1, and 1 crash respectively).

![Correlations Between Red Light Running Crashes & Red Light Violations(OBT & Sand Lake)](image)

Figure 5.3: Intersection 3 - Correlation between Red Light Running Violations and Red Light Running Crashes

After plotting the results for the red light running crashes and the average number of violations per hour for each approach as shown in Figure 5.3, we can see that there is high number of violations per hour with low number of crashes and high crashes with low rate of violations. We checked the correlation factor between the average violations per hour and the
frequency of crashes ($R^2 = 0.1177016$), Therefore we can conclude that there is no correlation between the red light running crashes and average violations per hour at the intersection of OBT and Sand Lake Road.

5.1.4 US 17-92 (Orange Blossom Trail) and Taft Vineland Road

At the fourth intersection, the highest average violations occurred for the southbound left turning movement and westbound left turning movement (16.44 and 11.53 average violations per hour respectively). The lowest average violations occurred for the northbound left turning movement (1.84 average violations per hour). It should be noted that the violations data for the eastbound left turning vehicles was missing since the camera for this location did not function properly.

As far as the number of crashes, the highest number of crashes occurred for the eastbound through movement (4 crashes). The lowest number of crashes occurred for the eastbound left turning movement, the westbound through movement, the westbound left turning movement, and the northbound through movement (no crashes).
Figure 5.4: Intersection 4 - Correlation Between Red Light running Violations And Red Light Crashes.

After plotting the results for the red light running crashes and the average number of violations per hour for each approach as shown in Figure 5.4, we can see that there is high rate of violations with low number of crashes and high crashes with low rate of violations. We checked the correlation factor between the average violations per hour and the frequency of crashes ($R^2 = 0.018385$), Therefore we can conclude that there is no correlation between the red light running crashes and average violations per hour at the intersection of OBT and Taft Vineland Road.
5.1.5 US 17-92 (Orange Blossom Trail) and West Holden Avenue

At the fifth intersection, the highest average violations occurred for the southbound through movement and the northbound through movement (9.91 and 9.67 average violations per hour respectively). The lowest average violations occurred for the eastbound through movement and the westbound through movement (1.39 and 1.23 average violations per hour respectively). It should be noted that the violations data for the eastbound left turning vehicles and the westbound left turning movement was missing since the camera for this location did not function properly.

As far as the number of crashes, the highest number of crashes occurred for the southbound through movement, the northbound through movement and the southbound left turning movement (3, 2, and 2 crashes respectively). The lowest number of crashes occurred for the northbound through movement, the northbound left turning movement, and the southbound left turning movement (no crashes).
After plotting the results for the red light running crashes and the average number of violations per hour for each approach as shown in Figure 5.5, we can see that there is high rate of violations corresponding to high number of crashes. We checked the correlation factor between the average violations per hour and the frequency of crashes ($R^2 = 0.75905226$), therefore there is a reason to believe that there is correlation between the red light running crashes and average violations per hour at the intersection of OBT and Holden Avenue. A more detailed data collection would be needed to support this initial observation.
After analyzing the data for the five intersections we can conclude that there is no reason to believe that there is a correlation between the average of red light violations and the number of red light running crashes for the five intersections observed. The limited observation period coupled with few number of intersections that had red light running cameras installed at made it difficult to draw statistically reliable conclusions about any possible correlations between violations and crashes. Furthermore, there is other factors correlated with the red light running crashes at any intersection such as approach flow rate, cycle length, yellow interval duration, running speed, clearance path length, platoon ratio, use of signal head back plates, use of advance detection, and other factors that were not taken into consideration in this analysis.

5.2 Correlation between Total Crash Rate and the Average Red Light Running Violations

In this section, the correlation between the number of crashes per 1 million vehicles crossing for each intersection (crash rate) and the average red light running violations per one million vehicles crossing at each intersection was studied. The crash rate and the number of vehicles crossing the intersection were obtained from the Orlando Urban Area 2004 Crash Surveillance Report shown in Table 5.7. The average violations per hour was calculated as the total violations at the intersection divided by the hours recorded considering that some of the red light cameras were not functioning properly at some locations during the studied time period.
Table 5.7: Red Light Running Crash and Violation Rate Per One Million-Crossing Vehicle

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Crossing Vehicle (million)</th>
<th>Average Violations/hour</th>
<th>Crash Rate*</th>
<th>Violation Rate**</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBT &amp; Sand Lake</td>
<td>41.379</td>
<td>43.33</td>
<td>1.45</td>
<td>1.047</td>
</tr>
<tr>
<td>OBT &amp; Taft Vinland</td>
<td>31.155</td>
<td>NA*</td>
<td>1.99</td>
<td>NA</td>
</tr>
<tr>
<td>Alafaya &amp; Colonial</td>
<td>42.963</td>
<td>36.78</td>
<td>1.35</td>
<td>0.856</td>
</tr>
<tr>
<td>OBT &amp; Holden Ave</td>
<td>29.249</td>
<td>NA*</td>
<td>2.53</td>
<td>NA</td>
</tr>
<tr>
<td>SR 50 &amp; Hiawassee</td>
<td>32.16</td>
<td>9.47</td>
<td>1.71</td>
<td>0.294</td>
</tr>
</tbody>
</table>

*Crash rate is the total number of accidents per one million-vehicle crossing.

**Violation rate is the number of red light running crashes per one million-vehicle crossing.

Based on the results of the analysis, the correlation factor between the crash rate and violation rate per one million-vehicle crossing for three intersections was found to be 0.68 indicating a low correlation between the total crash rate and the violation rate for these intersections. It should be noted that this part of the analysis was conducted using limited amount of data.
CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

A primary purpose of this research was to assess the scope and effects of red light running related traffic signal crashes in Florida. The analysis was conducted using three years of Florida crash data (2002-2004) provided by the Department of Highway Safety and Motor Vehicle (DHSMV) CD. Based on the analysis of the studied data, the following was found:

- 20,752 red light running related crashes occurred in Florida from 2002 to 2004.
- “Failed to Yield Right of Way” was found to be the highest second contributing cause
- The rate of red light running violations was approximately 25 per 1,000 licensed drivers.
- The rate of red light running crashes was approximately one crash per 2,000 licensed drivers.
- The total crash rate was found to be approximately 20 crashes per 1,000 licensed drivers.
- Over 90% of the crashes related to red light running involved through vehicles and less than 10% of the crashes related to red light running involved left turning vehicles.
- Approximately 65% of the crashes were angle crashes and that approximately 10% of the crashes were left turn collisions.
- Motorists involved in red light running crashes are more likely to be males than females.
• The younger age groups (16 to 20 and 20 to 25 year old) are more likely to be involved in a red light running related crash compared to other age groups. The older age groups accounted for a relatively small portion of red light running crashes.

• Red light runners that involved DUI were more likely to be young.

• More red light running crashes (approximately 60%) occur during the p.m. time period.

• Slightly higher crashes related to red light running were observed occurring on Fridays and Saturdays compared to other days of the week, however, the difference between the different days was not significant.

• The average red light running crashes are higher on urban road compared to rural road.

• Most of the crashes related to red light running occurred during clear weather (more than 70%), which indicate that the influence of cloudy, rain, fog, and all other weather condition are insignificant.

• Only 23% of crashes related to red light running have no injuries, and around 77% of the total crashed related to red light running has different level of injuries.

• Red light running crashes in Florida for the years (2002, 2003 and 2004) accounts for more than 9000 injuries, and more than 60 death a year.

• The total amount of damage form crashes related to red light running in Florida is around 60 million dollars a year.
In the second part of this research, the actual hard copy crash reports files were analyzed and compared with the data obtained from the CAR database for a small sample (five intersections) to investigate if errors often occur in how information on a red light running crash report is coded in the computerized crash database. The analysis showed that the results from the CAR system and from the crash report forms are different in reporting the actual number of red light running related crashes. The findings presented in this research imply that the red light running crashes are being underreported if only the CAR system is utilized. To obtain more accurate results, the long forms crash reports should be analyzed.

- The percentage of red light running crashes reported in the CAR system was 3.25%. These crashes had “Disregarded Traffic Signal” as the first contributing cause.
- The actual percentage based on the detailed analysis of the long form crash reports of red light running was found to be 7.31%, which is more than double the number of crashes reported by the CAR system.

Some of the frequent problems found in coding the red light running crashes were:

- Not filling the contributing cause at all.
- The no fault driver was coded first although the second driver had Disregarded Traffic Signal as a contributing cause.
- Coding left turning vehicles running red light as Improper Turn.
- When there is conflict where both left turning vehicle and through vehicle claimed to have a green arrow and a solid green respectively, the contributing cause is coded All Other.
• Coding failing to stop and entering the intersection as Careless Driving.
• Coding failing to stop and entering the intersection as Failed to Yield Right-of-Way.
• Mistakenly coding the contributing cause as Disregarding Other Traffic Control.

Using a larger sample (1% random sample from the 2004 crash data for the state of Florida), the percentage of red light running crashes reported in the CAR system was found to be 3.13%. These crashes had “Disregarded Traffic Signal” as the contributing cause. Based on the detailed analysis of the long form crash reports, it was found that the actual percentage of the red light running crashes was 5.63%. The previous research shows the importance of standardizing the format and coding process for the long form crashes by the police officers to help identify the real pattern of crashes at any studied location.

In the third part of this research, the correlation between the average violations per hour and the red light running crash rates at the five intersections were studied. The following was found:

• At the intersection of SR 50 and Alafaya, there was no correlation between the red light running crashes and Average violation per hour
• At the intersection SR 50 and Hiawassee Road, there was no correlation between the red light running crashes and Average violation per hour at this intersection.
• At the intersection of OBT and Sand Lake Road, there was no correlation between the red light running crashes and average violation per hour at this intersection.
• At the intersection of OBT and Taft Vineland Road, there was no correlation between the red light running crashes and average violation per hour at this intersection.

• At the intersection of OBT and Holden Avenue, it appears that there is a reason to believe that there was a correlation between the red light running crashes and average violation per hour at this intersection.

It should be noted that the last part of the analysis was conducted using limited data since the violations data was only available for three months period at the time of the research.
REFERENCES


