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A Study on the Effectiveness of Iowa's Driver Improvement Program by Gender and Age

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A study on the effectiveness of Iowa's driver improvement program by gender and age

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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ABSTRACT

This study examines the effectiveness of Iowa's Driver Improvement Program (DIP) by gender and age, measured as the reduction in the number of driver convictions and crashes subsequent to the DIP. The analysis involved a random sample of 9,055 drivers who had been directed to attend DIP and corresponding data on driver convictions, crashes, and driver education training history that were provided by the Iowa Motor Vehicle Division. The sample was divided into two groups based on gender (female and male), and three groups based on age (30 years old or younger, 31 to 40 years old, and older than 40 years old). In each specific group, the sample was then divided into two groups based on the DIP outcome, satisfactory or unsatisfactory completion. The evaluation period considered was one year after the DIP date (probation period) for each driver in the random sample.

The evaluation of Iowa's DIP showed that there is evidence of effectiveness in terms of reducing driver convictions subsequent to attending the DIP. Among the 6,790 (75%) drivers who completed the course satisfactorily, 73% of drivers had no actions and 93% were not involved in a crash during the probation period. Turning to the differences by age and gender, male drivers and young drivers (30 years old or younger) incurred more convictions, while older drivers (40 years old or older) had fewer crashes in both the satisfactory and unsatisfactory groups. Drivers in the satisfactory groups had lower conviction rates but more crashes than those in the unsatisfactory group. Econometric modeling estimation results showed that, regardless of the DIP outcome, the likelihood of a conviction and frequency of subsequent convictions depends on other factors such as age, driver history, and DIP location, and interaction effects among these factors. The association rules show that DIP is

not associated with a reduction in the likelihood of the occurrence of one crash after DIP. This is consistent with previous studies in which the effectiveness of DIP in reducing subsequent crashes could not be established.

Low-cost, early intervention measures are suggested to enhance the effectiveness of Iowa’s DIP. These measures include advisory and warning letters (customized based on the driver’s age) sent within the first year after the DIP date and soon after the end of the probation period, as well as a closer examination of DIP instruction across the 17 community colleges that host the program. Given the large number of suspended drivers who continued to drive, consideration should also be given to measures to reduce driving while suspended offenses. Other states also can benefit from this study and results.

CHAPTER 1. OVERVIEW

1.1 Problem Statement

Driver Improvement Programs (DIPs) have been widely used in the United States, as well as internationally. The objective of a DIP is to reduce the number of traffic rule violation convictions and crashes in a driver's history and help drivers correct their potentially dangerous driving behaviors. DIPs have been conducted in the United States for over 60 years. Intervention strategies and programs vary across states but typically include warning letters, educational materials and courses, diagnostic reexaminations, individual counseling, and license suspension/revocation. In most previous studies, improvement interventions generally resulted in a reduction in violations, but the crash effects were less pronounced.

The Iowa DOT, like in other states, offers its own unique DIP (Iowa DOT 2007). It was established and fully implemented in 2001. Iowa's Driver Improvement Program (DIP) targets drivers who have received multiple citations for moving violations. These drivers include those who have been convicted three or more countable moving violations (including out-of-state violations) committed within a 12-month period or who have been convicted of a speeding violation of 25 to 29 miles per hour over the posted speed limit. Under this program, those drivers are required to attend and successfully complete driver improvement school, at the driver's own expense, a program approved by the Iowa DOT in lieu of driver's license suspension. Currently, 17 community colleges across the state of Iowa offer the approved program.

Although previous studies have certainly provided important insights in the effectiveness of DIPs (or select driver interventions), there are few studies on evaluating DIP's effectiveness by gender and age. Therefore, there is a need to investigate differences in conviction and crash occurrence subsequent to DIP by gender and age. Furthermore, there is a need to investigate whether there are any spatial differences in the effectiveness of DIP in the various sites (i.e., community colleges) across the state that driver improvement courses are offered.

1.2 Research Objectives

This thesis investigates the effectiveness of Iowa's Driver Improvement Program by gender and age. A random sample of driving records of drivers who were directed to attend DIP was provided by the Motor Vehicle Division. The database includes driver and action-specific information. Driver-specific information includes gender, age, license class, date sent to DIP, location of DIP, and DIP outcome (satisfactory or unsatisfactory completion). Action-specific information included the action type, reason code, driver participant ID number, actual speed, posted speed limit, jurisdiction and crash case number. Statistical analysis were conducted to investigate the effect of factors, such as gender, age, DIP outcome, DIP location, and interaction effects among these factors on occurrence and frequency of subsequent convictions/crashes. These findings are compared by gender and age and concluding remarks are offered. The following discusses the major five tasks and are accompanied by a discussion of the anticipated benefits.

Task 1: Synthesis of the State of the Practice and Literature Review

An overview of the different DIPs offered across the nation and the findings of past studies regarding the effectiveness of those different programs will be provided. The literature review includes the overview of Iowa's DIP, and synthesis of DIPs in other states. Eight types of DIP (educational/info material, group meeting, individual meeting, letter, license suspension/revocation, license extension, point reduction, and probation) identified in the literature are also reviewed and presented.

Task 2: Review of Past Methodologies and Selected Methodology for This Study

An overview of the different methodologies applied for investigating the effectiveness of DIPs is provided, including comparative methods, survival analysis, autoregressive integrated moving average (ARIMA) models, and analysis of covariance methods. The selected methodology for this study also is discussed.

Task 3: Descriptive Data Analysis

The data on drivers who were instructed to attend DIP, provided by the Motor Vehicle Division, are summarized and interpreted using descriptive analysis techniques and graphical representations.

Task 4: Investigation of Differences in DIP's Effectiveness by Gender and Age

Potential differences by gender and age in the program's effectiveness are investigated. Statistical analyses are conducted to compare the likelihood and frequency of convictions/crashes subsequent to DIP of female and male drivers, and also of drivers in three age groups. Evaluating such differences can help to identify strategies to improve the effectiveness of the program.

Task 5: Conclusions and Recommendations

Based on the work conducted for the previous tasks, recommendations regarding the effectiveness of the current program are offered. Additional, research needs are identified as well.

1.3 Thesis Organization

Table 1.1 Tasks for this thesis and the corresponding chapters.

Task	Corresponding Chapter
Introduction	1. Introduction
1. Synthesis of the State of the Practice and Literature Review	2. Literature Review
2. Review of Past Methodologies and Selected Methodology for This Study	3. Methodology
3. Descriptive Data Analysis	4. Data Collection and Descriptive Analysis
4. Investigation of Differences in DIP's Effectiveness by Gender and Age	5. Statistical Data Analysis
5. Conclusions and Recommendations	6. Conclusions and Recommendations

CHAPTER 2. LITERATURE REVIEW

2.1 Overview of Driver Improvement Program

2.1.1 Overview of Iowa's Driver Improvement Program

The Iowa DOT, like in other states, offers its own DIP (Iowa DOT 2007). It was established and fully implemented in 2001. Pertinent sections of the Iowa Code are provided in Appendix A, and the specifics of the program are summarized below.

2.1.1.1 Suspension of driving privileges

Driving privileges may be suspended in the following circumstances:

- Habitual Violator

  Drivers have been convicted of or pled guilty to three or more countable moving violations (including out-of-state violations) that were committed within a 12-month period.

- Serious Violation

  Drivers have been convicted of or pled guilty to speeding 25 miles or more over the legal speed limit.

- Countable Moving Violations

  This circumstance includes all moving violations, except the first two speed convictions within a 12-month period, that occur in speed zones between 34 and 56 mph and that involve drivers who were convicted of speeding 10 mph or less over the posted speed limit. A moving violation is defined to include all violations not specifically excluded by Iowa Code 321.210. (Examples of excluded violations include parking violations, failure to appear, equipment violations, registration violations, or disturbing the peace with a motor vehicle.)

2.1.1.2 Driver improvement school

2.1.1.2.1 Drivers over 17 years old

When a driver's record shows convictions of three countable moving violations committed within a 12-month period or when the driver has been convicted of a speeding violation of 25 to 29 miles over the limit, drivers may be required to complete a driver improvement school at the drivers' local community college. After drivers have successfully completed the program, they will be on probation for one year. If drivers are convicted of a moving violation while on probation, the Iowa DOT's Office of Driver Services will start action to suspend their license. A suspension notice will also be mailed to drivers if they fail to complete the DIP.

2.1.1.2.2 Drivers under 17 years old—Graduated driver licenses

In Iowa, a Graduated Driver License (GDL) program has been implemented for drivers under the age of 17. The program issues three kinds of licenses: instruction permit, intermediate license, and full license. The law went into effect January 1, 1999, and has since been supplemented.

Instruction Permit

Eligibility requirements:

- This permit is available at age 14.
- Written consent of a parent/guardian is required. This consent may be given using one of two options: (1) the parent/guardian accompanies the teenager to the driver's license station to sign the consent form in the presence of the examiner or (2) the parent/guardian downloads the form “Parent’s Written Consent to Issue Privilege to Drive or Affidavit to Obtain Duplicate License Form #430018” and signs the form in the presence of a notary public. The teenager may then present the completed and notarized form to the examiner, and the parent/guardian would not have to accompany the teenager to the driver’s license station.
- The permit requires satisfactory performance in vision screening and knowledge tests.
- Proof of identity and verification of a Social Security number is required.

Conditions:

- The permit must be held for a minimum of six months.
- All driving must be supervised by a licensed driver. Drivers may drive only with a parent/guardian, an immediate family member over age 21, a driver education teacher, or a driver over 25 with written the permission of a parent/guardian.
- The number of passengers is limited to the number of safety belts available in vehicle.

- The driver must complete 20 hours of driving under adult supervision; a minimum of two hours must be between sunset and sunrise.
- The driver must drive accident-free and violation-free for the six consecutive months immediately preceding application for an intermediate license. The permit must not be expired or withdrawn during this six-month period.
- The driver must complete an Iowa-approved or comparable driver education course:
    - 30 hours of classroom instruction that must include four hours of substance abuse education, a minimum of 20 minutes on railroad crossing safety, and information on organ donation
    - A six-hour laboratory, three hours of which must be behind the wheel; may use simulators for the remaining time
    - No parental waiver of any behind-the-wheel drive time
- The instruction permit will have the words “under eighteen” printed on it.

Intermediate License

Eligibility requirements:

- This license is available at age 16.
- The driver must meet all the conditions of the instruction permit.
- The written consent of a parent/guardian is required. This consent may be given using one of two options: (1) the parent/guardian accompanies the teenager to the driver’s license station to sign the consent form in the presence of the examiner or (2) the parent/guardian downloads the form “Parent's

Written Consent to Issue Privilege to Drive or Affidavit to Obtain Duplicate License Form #430018" and signs the form in the presence of a notary public. The teenager may then present the completed and notarized form to the examiner, and the parent/guardian would not have to accompany the teenager to the driver's license station.

Conditions:

- This license must be held for a minimum of 12 months.
- The driver may drive in the following conditions:
  - Without supervision from 5:00 a.m. to 12:30 a.m.
  - Between 12:30 a.m. and 5:00 a.m. only with a licensed driver who is a parent/guardian, immediate family member over 21, or a designated adult over 25.
  - With a waiver between 12:30 a.m. and 5:00 a.m. to and from work or school-related extracurricular activities.
- The driver must complete 10 hours of driving under adult supervision; a minimum of two hours must be between sunset and sunrise. The supervision must be by a licensed driver who is a parent/guardian, immediate family member over 21, or designated adult over 25.
- The number of passengers is limited to the number of safety belts available in vehicle.
- The driver must drive accident-free and violation-free for the 12 consecutive months immediately preceding application for full license. The intermediate license must not be expired or withdrawn during this 12-month period.

- The intermediate license will have the words “under eighteen” printed on it.
- Up to age 18, all conditions of the intermediate license shall remain in effect until the holder of the intermediate license has been issued a full license.

Full License

Eligibility requirements:

- This license is available at age 17.
- The driver must meet all conditions of the intermediate license.
- Written consent of a parent/guardian is required. This consent may be given using one of two options: (1) the parent/guardian accompanies the teenager to the driver’s license station to sign the consent form in the presence of the examiner or (2) the parent/guardian downloads the form “Parent's Written Consent to Issue Privilege to Drive or Affidavit to Obtain Duplicate License Form #430018” and signs the form in the presence of a notary public. The teenager may then present the completed and notarized form to the examiner, and the parent/guardian would not have to accompany the teenager to the driver’s license station.

Conditions:

- Full driving privileges are granted with no restrictions.
- For drivers under age 18 or age 21, the license shall have the words “under eighteen” or “under twenty-one,” respectively, printed on it.

2.1.1.2.3 Remedial driver improvement

- This applies to drivers either holding an instruction permit or an intermediate license.
- The driver will be referred to the remedial driver improvement process if involved in one moving violation or if involved in an accident to which the driver contributed.
- Both the driver and a parent/guardian must participate in an interview with an Iowa DOT official.
- The Iowa DOT official may impose additional driving restrictions and/or recommend license suspension.
- From the date the traffic violation occurred—not the date of the conviction—or the date of the contributive accident, the license holder must begin a six-month (for instruction permit holders) or 12-month (for intermediate license holders) accident-free and violation-free driving period again to qualify for the next licensing level.

2.1.1.3 Driving while suspended

Driving while a drivers' license is suspended is a misdemeanor. A conviction may result in a $1,500 fine and up to one year in jail if the driver is convicted of a serious misdemeanor. The length of suspension or revocation for some convictions may also be doubled if drivers are convicted of driving while their license is suspended. A work permit cannot be issued when drivers have been convicted of driving while their license was suspended. Drivers may also be barred from driving (under the provisions of Iowa Code

Section 321.555) if they are convicted for driving while under suspension (Iowa Code Section 321.218 and 321A.32 Subsection 1).

2.1.1.4 Habitual offender

Drivers will be barred for two to six years (Iowa Code Section 321.555 Paragraph 1) if they receive three or more of any combination of the following convictions in a six-year period:

- Manslaughter with a motor vehicle
- Conviction of operating while under the influence of alcohol or drugs (Iowa Code Chapter 321J)
- Conviction for driving while license is suspended, revoked, or barred; eluding or attempting to elude pursuing law enforcement vehicles; or serious injury by vehicle
- Failure to stop and leave information or render aid at the scene of an accident in which driver was involved, as required by Iowa Code 321.263

2.1.1.5 Financial responsibility

Any suspension as a result of moving convictions or any revocation for operating while intoxicated (OWI) and implied consent (Chapter 321J) requires compliance with Iowa's financial responsibility law. This requirement is normally met by filing proof of at least $55,000 insurance coverage. Otherwise, drivers must post security of $55,000 by certified check, cashier's check, money order, or surety bond. This filing must be maintained for two years.

2.1.1.6 Driver improvement and driving record

The completion of a driver improvement course, probation period, or a suspension does not clear the driving record of any entries showing violations or accidents. The driving record will show all convictions, accidents, or suspensions during at least the previous five years. A license revocation for OWI will remain on the driver's record for 12 years.

2.1.1.7 Out-of-state moving traffic violations

Convictions for moving traffic violations in other states count against the driver's record. The Iowa DOT determines the action to be taken concerning driving privileges.

2.1.1.8 Calculating dates of traffic violations

The dates on which the offenses occurred, not the dates on which drivers are convicted of traffic violations, are considered when determining how many violations have taken place in a specified time period.

2.1.1.9 Driver improvement and commercial driver's licenses

Operators of commercial motor vehicles may be subject to additional penalties.

2.1.2 Driver Improvement Programs in Other States

2.1.2.1 Online driver education courses

The online driver education course "I Drive Safely" has been approved in the following 15 states: Alaska, Arizona, Delaware, Florida, Kansas, Idaho, Maine, Missouri, Nevada, New Jersey, New Mexico, New York, North Dakota, Texas, and Virginia. Table 2.1 shows the online driver education courses that are offered across the nation

Table 2.1. Online driver education courses across the nation

Type of Program/Course	**State where the Program/Course is offered**
Traffic school	Alabama, Arkansas, California, Connecticut, Florida, Maine, Missouri, Nevada, North Carolina, Virginia
Defensive school	Alaska, Arizona, Colorado, Delaware , Georgia, Hawaii, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South California, Tennessee, Texas, Utah, Vermont, Washington, Washington D.C., West Virginia, Wisconsin, Wyoming
Court-referred courses when drivers get ticket	Arkansas, California (once every 18 months), Colorado, Connecticut, Florida (4, 8, or 12 hr long), Georgia, Hawaii, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New York ,Oklahoma, Oregon, Pennsylvania, Rhode Island, South California, Tennessee, Utah, Vermont, Washington, D.C., West Virginia, Wisconsin, Wyoming, Missouri, Nevada, New Mexico, Texas, Virginia, Washington (4 or 8 hr long)
Court-permission courses when a driver gets a ticket	Arizona (also required to pay a fine), Kansas, Ohio
Court-ordered courses when a driver gets a ticket	Alabama, Alaska , North Carolina
Aggressive driver courses	Delaware
Point reduction	Alaska (2 points), Idaho, Maine (3 points), Nevada (3 points once every 12 months), New Jersey, New Mexico (when license is suspended), Virginia

Table 2.1 (continued)

Type of Program/Course	State where the Program/Course is offered
Insurance discount	Arkansas, California (three-year renewal courses), Connecticut, Delaware (three-year refresher/renewal course), Georgia, Hawaii, Idaho (for drivers older than 55), Illinois, Indiana, Iowa, Kansas (three-year), Kentucky, Louisiana, Maine (for drivers older than 55), Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, New Hampshire, New York, North Dakota (up to 5% for a two-year period), Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Washington DC, West Virginia, Wisconsin, Wyoming Mature Driver Improvement (MDI): California, Colorado, Florida, Maine, Maine, Nevada, New Jersey, New Mexico, North Dakota, Washington
Teen driver education courses	California, Colorado, Florida, Nevada, Oklahoma, Texas

Most states' online driver program is called "defensive school," while in 10 states it is called "traffic school." There is not much difference between these two kinds of programs.

In Alabama, Alaska, and North Carolina, drivers who have received a ticket need to receive permission from the court or judge to take a driving safety course. Drivers in other states are ordered or referred by the court to take the defensive course. The referred classes are not officially approved in those states. Taking this course may satisfy a court requirement or count towards an insurance discount. Drivers who take an online driver safety course, which most defensive schools offer, are eligible for an insurance discount. In Arizona, in addition to taking the defensive course ordered by a judge, drivers also pay a fine. Only one state, Delaware, offers the aggressive driver course. Drivers who have been cited as aggressive by the Delaware Division of Motor Vehicles need to attend an "Aggressive Driving Behavior Modification/Attitudinal Driving Program."

An online point reduction course (PRC) is offered in seven states, but different policies are in place. After taking a driver education course, drivers in Alaska and New Jersey can have two points erased from their record, while drivers in Maine and Nevada can have three points removed from their record. In New Mexico, drivers are required to take this course only when their license is suspended, while drivers in Idaho cannot take courses if their licenses have been suspended through the point system.

An insurance discount incentive is popular in 40 states. Some drivers earn this discount by taking an online driver safety course, while others earn this discount by completing a mature driver improvement (MDI) program. For example, PRC qualifies drivers who are 55 years of age or older for an insurance discount in Idaho and Maine. There is no limitation of age for the insurance discount in New Jersey; however, there is 5% discount for a three-year period if a driver's number of points is less than four. This course may only be completed once every 36 months in Idaho but can be completed every year in Nevada. In Delaware, drivers who have not taken a "Delaware Defensive Driving" course within the past 36 months can take a six-hour course and receive a three-point credit on their driver record, as well as a 10% discount on their auto insurance premium. Drivers who have taken a "Delaware Defensive Driving" course within the past 36 months can take a three-hour refresher course and receive a 15% credit on their auto insurance premium.

Finally, there are only six states who offer "Driver Education Courses" for teen drivers, as shown in Table 2.1.

2.1.2.2 Other driver improvement programs

Besides online courses, states also have other programs that vary from state to state. In a meta-analysis of the driver improvement literature, Masten and Peck (2004) classified DIP interventions into eight categories: educational/info material, group meeting, individual meeting, letter, license suspension/revocation, license extension, point reduction, and probation.

An overview of these programs by state is presented in this section, while information on each program's effectiveness is provided in Chapter 3.

Arizona has established the "Traffic Violators School" (TVS) and "Traffic Survival School" (TSS). TVS aims to teach drivers how to survive under different types of traffic conditions, while TSS encourages more lawful driving behavior and targets mainly persistent violators. In California, "California's Traffic Violator School Citation Dismissal Policy" offers drivers the opportunity to complete a course and have their citations dismissed.

High school driver education is offered in North Dakota, Illinois, California, Colorado, Florida, Nevada, Oklahoma, and Texas. A graduated licensing system (GLS) was first offered in Florida, Michigan, and North Carolina and then became a nationwide policy in an effort to reduce the crashes experienced by teen drivers. GDL limits the age at which drivers may get the license permit, allows driving only under the safest conditions (for example, with an experienced, responsible adult driver in the vehicle), and places time restrictions on driving at night and on weekends.

Illinois, Maine, Pennsylvania, Virginia, and Oregon issue warning letters, which are argued to be a low-cost, early intervention measure to warn large numbers of drivers before they become high-risk drivers and/or are involved in a crash. In Oregon, there are four steps in the DIP: advisory letters, warning letters, probation, and suspension. According to the classification by the letter content, warning letters can be divided into standard warning letters and soft-sell letters.

Home-study courses are offered in Connecticut, Florida, Minnesota, Nevada, New Mexico, Oklahoma, Texas, and Virginia. California provides one home-study course under the mature driver improvement program, which helps 55-year-old or older drivers enhance their driving skills and knowledge.

Table 2.2. Other driver improvement programs

State	**Driver Improvement Program**
Arizona	• Traffic Violators School (formerly Traffic Survival School)
California	• Vehicle control (impoundment/forfeiture) • Home-study courses for older drivers • Point system • Traffic Violator School Citation Dismissal Policy • Mature driver improvement • High school driver education
Connecticut	• Checkpoints program on parent-imposed driving limits • Home-study courses
Colorado	• High school driver education
Florida	• AARP Driver Safety Program • Graduated driver licensing • High school driver education • Home-study courses
Illinois	• A four-hour training course offered at Traffic Safety School • High school driver education • Warning letters
Maine	• Warning letters
Michigan	• Graduated driver licensing
Minnesota	• Home-study course

Table 2.2 (continued)

State	Driver Improvement Program
New Jersey	• License control (suspension/revocation)
New Mexico	• Home-study courses
Nevada	• High school driver education • Home-study course
North Carolina	• Graduated driver licensing
North Dakota	• High school driver education
Ohio	• Vehicle control (impoundment/forfeiture)
Oklahoma	• High school driver education • Home-study courses
Oregon	• Advisory letters (standard and soft-sell) • Warning letters (standard and soft-sell) • License control (suspension/revocation) • Vehicle control (impoundment/forfeiture)
Pennsylvania	• Written re-examination • Warning letters
Texas	• High school driver education
Virginia	• Warning letters
Wisconsin	• Driver Improvement—Individual Counseling Program

2.1.3 Summary of Driver Improvement Programs

Iowa offers certain driving improvement programs, such as its driver improvement school; its policy of suspending driving privileges for habitual violators, serious violations, and countable moving violations; and its GDL program for drivers under 17 years old. The Iowa DOT can also consider adopting other driver education training mechanisms and materials, such as home-study courses (online courses), which have low costs but are not less effective than in-person programs; a mature driver improvement program, which is essential to refresh older drivers' skills and knowledge; and advisory or warning letters as a low-cost, early intervention measure to advise/warn drivers before they become high-risk drivers and/or are involved in a crash.

2.2 Effectiveness of Driver Improvement Programs

2.2.1 Overview

DIPs have been widely used in the United States, as well as internationally. The objective of the DIP is to reduce the number of traffic offense convictions and crashes in a driver's history and help drivers correct their potentially dangerous driving behavior. DIPs have been carried out in the United States for over 60 years, and there have been many evaluation studies of DIPs' effectiveness in reducing convictions and crashes. Meta-analyses or comparative studies of DIPs with regard to crashes and violations have concluded that driver improvement interventions generally result in a reduction in violations (Struckman-Johnson et al. 1989; Masten and Peck 2004). However, the crash effects were less pronounced (Ker et al. 2005) and, in some cases, mixed for different types of interventions. For example, Masten and Peck (2004) found that the distribution of educational or informational material was not associated with any crash reductions, in contrast to warning letters, group meetings, individual counseling, and license suspension/revocation. The types of driver improvement interventions (e.g., warning letters vs. group meetings), the orientation of driver improvement interventions (e.g., threatening vs. educational), or the type of participants (repeat offenders vs. first-time offenders) could potentially influence or moderate the effectiveness of driver improvement interventions. However, characteristics such as direct vs. indirect participant contact and group vs. individual contact were not found to be statistically significant factors for explaining the effectiveness of different DIPs (Struckman-Johnson et al. 1989).

This chapter provides the findings of a literature review on the effectiveness of different DIPs.

2.2.2 Review of Eight Types of DIP

As discussed in Section 2.2.2, there are eight types of interventions of DIPs in the United States: educational/info material, group meeting, individual meeting, letter, license suspension/revocation, license extension, point reduction, and probation.

2.2.2.1 Educational/information material

Educational/information material is effective to some extent when coupled with other driver control measures such as driver improvement letters, interviews, meetings, and probations. Epperson and Harano (1975) found that an informational pamphlet along with driver improvement letters can be effective in reducing the number of subsequent collisions and convictions of pre-negligent drivers. A written reexamination, which has been developed as one level of a multi-tiered driver improvement pilot program administered by the Pennsylvania Department of Transportation, was found to result in cost savings and in significant reductions in crash- and violation-involvement rates during a one-year evaluation period (Staplin 1993).

2.2.2.2 Group meetings

A group meeting could include attending a traffic school; the eight-hour National Safety Council (NSC) Defensive Driving Course in Washington, DC; interviews (such as the Narrative Driving Group Interview); and specific meetings, such as the Group Educational Meeting, Speed Educational Meeting, Subject Interaction Meeting, and Driver Improvement Meeting.

The NSC is the premier provider of defensive driver training in the nation. In addition to the nationally recognized courses, NSC also offers state-certified programs through their Data Management Center to meet the needs of several states' regulations. Currently, each state has an NSC training center, but the regulations about insurance discounts and point reductions from the driver's record vary by state. Most defensive driving courses are offered online. Lund and Williams (1985) reviewed the literature on the effectiveness of this program, which included 124 controlled studies. Two-thirds of these studies showed a decrease in the frequency of traffic violations by about 10%. The remaining one-third of these studies did not support the finding that defensive driving courses resulted in a decrease in motor vehicle crashes. However, the authors found the results of these studies to be questionable and inadequate as assessments of defensive driving courses' effectiveness.

The four-hour training course offered at the Traffic Safety School in Cook County, Illinois, for drivers who have received their first traffic citation was evaluated for effectiveness in terms of reducing traffic violations. The study (Raub et al. 1999) concluded that the program was effective, but the effectiveness seemed to taper off 6 months after training for traffic citations and 90 days for traffic stops.

In Arizona, traffic violators could keep their driver licenses by taking the TSS and learning how to survive in the traffic environment. The TVS program was initiated in Arizona and targets persistent violators. McKnight and McKnight (1993) conducted an evaluation of traffic violation and traffic survival schools in Arizona over a two-year experimental period. The results showed that TVS resulted in a small but statistically significant decrease in crashes and violations over the 12 months immediately following the course assignment. However, there was no significant difference in violations during the second 12-month period. Because of the equal cost of administering the two programs, the authors questioned the statewide implementation of TVS due to the small differential benefit of the program. A recent study in Arizona (Michael, 2004) investigated the effect of TSS in terms of traffic violations and crash rates. The rates of receiving a second citation were not significantly different between the TSS-referral and non TSS-referral group, and crash rates were found to be even higher in the referral group.

2.2.2.3 Individual meetings

Individual counseling is for drivers who are about to be reinstated after a suspension or revocation. The Wisconsin Driver Improvement—Individual Counseling Program is an educational treatment approach used for habitual violators (drivers who accumulate a certain number of demerit points in a given period of time or who are about to have their licenses reinstated following a revocation/suspension). Fuchs (1980) evaluated the effectiveness of an individual counseling program offered in Wisconsin and reported no beneficial effects.

2.2.2.4 Letters

Driver improvement letters are argued to be a low-cost, early intervention measure to warn large numbers of drivers before they become high-risk drivers and/or are involved in a crash.

Oregon's DIP originally consisted of four steps: advisory letters, warning letters, probation, and license suspension. Drivers with multiple convictions were sent an advisory letter to remind them to drive more safely, and then, upon receiving subsequent convictions, they were sent a warning letter about future sanctions, such as license suspension. Advisory letters could have different emphases; the content of standard letters emphasized the threat of subsequent accidents or violations, while soft-sell letters provided more emphasis on positive motivations, encouragement, and benefits (such as saving money on traffic fines and insurance rates).

Kaestner et al. (1965) compared three kinds of letters: a standard letter, a personalized version of the standard letter, and a personalized low-threat letter. The low-threat letter proved to be the most effective, although a personalized version of the standard letter also helped.

Jones (1997a; 1997b) evaluated the effectiveness of "high-threat" advisory letters and warning letters in Oregon and concluded that they are effective, but their effectiveness differs between men and women and among different age groups. Jones (1997a) also compared the effectiveness of two kinds of advisory letters in Oregon, a standard letter and a soft-sell letter, in terms of subsequent crashes, moving violations, and major violations during a 24-month period. With a Cox regression survival model, Jones (1997a) found that the recipients of advisory letters were involved in fewer traffic accidents and that the standard letter was more effective than the soft-sell letter. In addition, Jones (1997a) investigated the difference in effectiveness by age and by gender. It was found that standard letters were more effective for younger male and female drivers, while the soft-sell letters were more effective for drivers older than 45 years old. In a subsequent study, Jones (1997b) focused on the second level of the Oregon DIP: the warning letters. Using the same methodology (Cox regression survival model), Jones found soft-sell letters to be more effective than the standard warning letter. The difference in the effectiveness between the two types of letters is more pronounced for drivers over 25 years old than for younger drivers.

In 2002, the Oregon DIP changed from four steps (advisory letters, warning letters, probation, and suspension) to two steps (restriction and suspension). Strathman et al. (2007) evaluated the effectiveness of this change. The incidence of crashes and convictions were compared among DIP participants and random drivers during an 18-month period before suspension and an 18-month period after suspension. A regression-to-the-mean method and a multivariate analysis were undertaken to analyze the data. It was suggested to reinstate warning letters in Oregon because they were a cost-effective method for reducing safety risk.

In Virginia, Lynn (1983) evaluated the four most common DIPs that the state offered: (1) warning letters, (2) a one-time group interview, (3) the combination of a warning letter and the group interview, and (4) a personal interview followed by an eight-hour driver improvement clinic. The drivers were randomly assigned to treatment and non-treatment groups, and their driving records were compared at the end of the year. It was found that the group interview was the most effective “treatment” in reducing the violations, while the warning letters were the least effective. None of the treatments were effective in reducing the subsequent accidents. The study recommended that the warning letter be modified or replaced by the group interview as the entry-level treatment.

2.2.2.5 License control (Suspension/Revocation)

Drivers could have their driver's license suspended when they drive aggressively, have more than the allowed number of convictions within set timeframe, commit severe violations, have accumulated points, or have been charged with driving under the influence of alcohol. In some states (such as New Jersey and Oregon), drivers' privileges can also be suspended or revoked through a court order for failure to pay child support or for failure to maintain insurance. No state will issue a driver's license if the driver has an active suspension or revocation in another state.

Zimmerman and Fishman (2001) reported that around one-fourth of the drivers in New Jersey (220,427 out of a total of 867,065) had their driver's license suspended in 2000 because of failure to pay for the insurance charges. In addition, the authors claimed that a large number of suspensions could contribute to financial failures, and they recommended the following steps in order to remedy these problems: (1) provide for reasonable payment plans geared to income levels, (2) allow and authorize optional garnishment, and (3) permit individuals to drive legally during the payment period. Another report (Carnegie 2007) showed that there was no upward trend in the number of license suspensions in New Jersey and concluded from the study that license suspension in New Jersey was widely used as "punishment" or as a means to force drivers to appear in court or pay a fine.

A number of studies have concluded that license suspension and revocation are some of the most effective countermeasures for reducing the crash and traffic conviction rate of high-risk drivers. Jones (1987) found that Oregon's habitual traffic offender program was effective in reducing the risk of future major traffic convictions, non-major traffic violations, and crashes. Masten and Peck (2004) found that license suspension or revocation resulted in a 17% reduction in crashes and a 21% reduction in convictions. In an evaluation study of Oregon's DIP (Strathman et al. 2007), the authors concluded that the 11% decline in crashes and 13% reduction in Type A convictions they observed can be attributed to the effect of license suspension. However, since one of the objectives of license suspension/revocation is to eliminate driving for a given period, it is possible that much of the effect that is reported in the literature is attributed to reduced exposure and/or more careful driving during the suspension interval.

2.2.2.6 Vehicle control

Vehicle control (impoundment/forfeiture) is an intervention targeted to drivers who continue to drive while their licenses are suspended or revoked or while they do not hold a license. It is the strictest countermeasure against risky driving. The use of impoundment and forfeiture was first implemented in Manitoba, Canada (Beirness et al. 1997), and in Portland, Oregon (Crosby 1995), respectively. Both studies found that vehicle control measures were effective in reducing recidivism. However, Portland's forfeiture program did not affect the recidivism rate any more than if the vehicle had simply been impounded for a short period. In Ohio, vehicle impoundment and vehicle immobilization programs were implemented to target suspended/revoked and multiple driving under the influence (DUI) offenders. Evaluation studies (Voas et al. 1997; Voas et al. 1998) showed that these programs were effective in reducing the rates of subsequent DUI and driving while suspended offenses.

The impoundment and forfeiture laws in California came into effect in January 1995. Deyoung (1999; 2000) studied the general deterrent effect and specific deterrent effect associated with these laws. The first study showed that in the subsequent one-year evaluation period, drivers who had their vehicles impounded (because they continued driving while their license was suspended or revoked or who were unlicensed) had 23.8% fewer driving while suspended convictions, 18.1% fewer traffic convictions, and 24.7% fewer crashes than similar drivers whose vehicles were not impounded. The results also showed that repeat offenders were more influenced by vehicle impoundment sanctions. However, the later study in 2000, found no evidence that simply threatening to impound/forfeit the vehicles of suspended/ revoked drivers had a significant effect on those drivers' crash rates in California.

2.2.2.7 Point system

A point system is integrated into the driver improvement program of 35 states. Different offenses are assigned different points according to their degree of severity or potential hazard. Iowa is one of the eight states (which also include Illinois, Indiana, Massachusetts, Minnesota, Oregon, Washington, and Wyoming) that has a violation limit system. However, this special point system does not reflect the severity or hazard associated with moving violations (Strathman et al. 2007).

California's 8- or 12-hour Traffic Violator School with a Citation Dismissal can result in point reduction in the traffic violators' records. Courts in California may offer drivers who have been cited for traffic violations an opportunity to attend a TVS and have their citation dismissed. As such, no points will be added to the driving records of drivers who completed TVS courses and have court proof (Bloch 1997; Gebers 2007). Gebers (2007) examined the effectiveness of the California Traffic Violator School Citation Dismissal Policy using a quasi-experimental design, which was a methodological improvement from a prior evaluation study conducted in 1991. Two random groups of drivers were compared to one group receiving a TVS dismissal and to another group receiving a traffic conviction. Gebers (2007) found that the group of drivers who received the TVS citation dismissal experienced significantly more crashes than the convicted group in the subsequent one-year period, during which the difference in crashes increased from 4.83% to 10%. It was concluded from the results that the TVS citation dismissal policy had a negative impact on traffic safety, which suggested that the TVS citation dismissal probably caused an increase in crashes.

2.2.3 Other Specific Programs by State

In addition to the interventions in DIPs for general drivers, some specific programs are conducted for younger drivers and older drivers.

2.2.3.1 Graduated driver licensing

GDL programs were first implemented in Florida, Michigan, and North Carolina and then became a nationwide policy in a bid to reduce the number of crashes by limiting the age of drivers receiving license permits. There are three distinct stages: learner's permit, intermediate license, and full license stage, and restrictions vary by stage. In the first stage, teenagers are required to drive with an experienced, responsible adult driver in the vehicle. After six months when they step into the intermediate license stage, teenagers can have unsupervised driving during daytime, but they still need to have supervision when driving at night. Finally, there is no restriction at the full license stage.

Evaluation studies of the GDL in Florida (Ulmer et al. 1997), Michigan (Shope et al. 2001), and North Carolina (Foss et al. 2001) reported crash rate reductions of 9%, 25%, and 57%, respectively, for 16 year-olds. The behavioral impact of GDL on teenage driving risk and exposure was investigated by Karaca-Mandic (2008). It was found that GDL policies reduced accident rates and fatalities of 15- to 17-year-old novice drivers. In addition, more restrictive GDL policies and programs with nighttime restrictions could contribute greater reductions to teen driving prevalence during the night. However, exposing 15 to 17-year-old drivers to GDL cannot presume better drivers in the future.

In Connecticut, Simons-Morton et al. (2006) conducted the first statewide study on the effect of the checkpoints program on parent-imposed driving limits. Chi-squared and t-test analyses were applied, and the results showed that intervention from parents was higher at licensure, teens in the intervention group were significantly less likely to drive at night or at high speeds, and teens were less likely to commit a traffic violation than the comparison group in the subsequent 12-month period. However, the results showed that the program was not sufficient as a stand-alone approach to prevent violations and crashes.

2.2.3.2 Mature driver improvement courses

MDI courses are offered to older drivers in an effort to update their driving skills and knowledge. In California, MDI courses include information on defensive driving, traffic laws, and the traffic safety impact of driver fatigue and health for drivers ages 55 and older.

In Florida, the AARP Driver Safety Program (DSP) is mainly addressed to older drivers (50 years old and over). The program aims to enhance their driving skills in today’s increasingly challenging driving environment and help them adjust to common age-related changes, such as hearing, vision, and reaction time. McGwin and Owsley (2007) conducted two analyses in the state of Florida involving participants who took part in the AARP DSP in 2001 and 2002. One of the analyses compared violation and collision rates before and after the drivers attended a DSP program, and the other compared violation and collision rates between DSP participants and non-participants. Overall, it was found that, for DSP participants, there was a reduction in some types of collision and overall violation rates before and after attending the DSP program, but there was an increase in careless driving-related offenses and a higher rate of most common types of violations. The comparison between DSP participants and non-participants showed that, although the differences in collision rates either diminished or became inverted after DSP participation (such that participants had lower rates compared to non-participants), DSP participants still had a higher crash rate compared to the rest of population. As such, the program's effectiveness is debatable.

2.2.3.3 Home-study courses

Berube (1995) compared home-study courses to in-person courses that were offered as part of California's MDI program. The author conducted three analyses: the first one compared the drivers who had completed the course at home (treatment group 1) to drivers who had not taken an MDI course (control group), the second analysis compared drivers who completed an MDI course in person (treatment group 2) to the control group, and the last one compared the home-study participants to the in-person participants (treatment group 1 versus treatment group 2). The results showed that the in-person MDI courses were not more effective than the home-study courses in reducing the subsequent overall fatal/injury crashes or total number of citations. Moreover, it was found that neither of the two types of course delivery was helpful to drivers without any recent citations. However, the courses were effective in reducing the number of subsequent citations of drivers with a citation history. No decrease in fatal or injury crash rates was reported.

Another study, conducted by the California Department of Motor Vehicles (Masten and Chapman 2003) for the legislature of the State of California, evaluated four different types of course delivery: classroom instruction, a home-study course using a CD-ROM, a workbook home-study course, and an Internet/workbook home-study course. Almost 1,500 students were randomly chosen to participate in the study. The participants were first asked to complete a knowledge and attitude exam and then indicate their preferences for course delivery. There was no difference in effectiveness, but students tended to prefer CD-ROM–based home-study courses and Internet/workbook home-study courses to the workbook or classroom courses. As such, a low-cost home-study course was recommended as the first step in the driver education program.

2.2.3.4 Driver improvement clinics program

Similar to the point reduction courses, New Jersey, North Carolina, and Virginia offer the Driver Improvement Clinics (DIC) program, which can also help drivers remove points from their record. However, different rules apply in each state. For example, in North Carolina drivers can have three points removed if they accumulate seven points every five years, while in Virginia five points will be removed if a driver completes the DIC program. Henderson and Kole (1968) evaluated the effectiveness of the New Jersey DIC as a means of reducing accidents and violations. By constructing indices for crash and violation rates, the authors found that drivers who attended the DIC had lower crash and violation rates than the drivers in the control group over the same time period. It was concluded that the DIC was effective in reducing both violations and crashes. Waller and Padgett (1975) studied the profile of 951 DIC participants in North Carolina and unveiled significant differences in age, race, and sex and reported the annual miles driven between the DIC participants and the entire licensed population of North Carolina. Unfortunately, no recent studies on the DIC program have been conducted to ensure that the program remains effective.

2.2.4 Summary of the Literature

The literature review summarized eight basic types of DIPs and additional programs that are offered in some states. All DIP programs aim to reduce traffic offense convictions and crashes and to help drivers correct their potentially dangerous driving behavior. Several studies on DIP have been identified in the literature. In general, most programs were found effective in reducing drivers' violations at the beginning of the intervention. However, sustaining the program's effectiveness in the long-run in terms of reducing violations and helping reduce crash rates has not been fully established.

CHAPTER 3. METHODOLOGY

In this chapter, methodologies applied in previous studies of driver improvement programs are summarized first, and then the selected methodology for this study is described. Some methodologies have been widely used in previous studies. Examples of such methodologies include: comparative methods (such as percentage comparisons and statistical tests) that compare crash/crash rates among difference groups; survival analysis which determines the period of time (number of days) during which the effects of the programs (such as driver improvement courses, advisory letters, warning letters, etc) remain significant, and Cox-regression survival analysis. Other methodologies include: autoregressive integrated moving average (ARIMA) models which are fitted to time series data to better understand the effects of a treatment (such as vehicle impoundment) on the problem under study (such as crash rates); and analysis of covariance (ANCOVA) which can help increase statistical power on testing effects by inclusion of covariates. The methodology of this study includes the estimation of binary probit models and count data models to estimate the likelihood of conviction occurrence and frequency of subsequent convictions, and the use of association rules to estimate the likelihood of crash occurrence of subsequent crashes.

3.1 Summary of Methodologies Applied in Previous Studies

Comparative methods are widely used for the evaluation of the effectiveness of Driver Improvement Programs (DIP), or for identifying differences in effectiveness between two programs (for example, Traffic Violator School vs. Traffic Survival School), two groups (home-study participants and non-participants), or two different time series (before vehicle impoundment policy vs. after vehicle impoundment policy). In addition to the conventional comparison methods, meta-analysis methods have been applied (Struckman-Johnson et al., 1989; Masten and Peck, 2004). This quantitative method combines the results of a number of independent studies and synthesizes conclusions that may be used to evaluate the effectiveness of the program. Meta-analyses or comparative studies of driver improvement programs on crashes and violations have concluded that driver improvement interventions generally result in reduction in violations (Struckman-Johnson et al., 1989; Masten and Peck, 2004).

3.1.1 Comparison

*Percentage comparison*s have been used to examine difference between comparison groups. Michael (2004) applied this method to evaluate the effectiveness of Traffic Survival School (TSS) on traffic crash and violation rates in Arizona. Pre crash rates and post crash rates were compared between TSS attendance and non-attendance. Based on the percentage of number of drivers cited for crashes, non-referred drivers (crash rates of 7.2%) were involved in a significantly lower percentage of crashes than those who were referred to TSS (crash rates of 18.7%), but no significant differences were found in the subsequent crash rates between those who completed TSS (crash rates of 4.0%) and those who did not (crash rates of 3.7%).

Statistical tests are typically conducted to compare different groups of drivers (experimental group versus control group, different age groups, gender groups), as well as the same groups of drivers before and after courses. Statistical differences in the number of violations, crashes, violation rates and crash rates are explored among the aforementioned groups. *Z-test or t-test statistic* was used to compare these differences among normally distributed-populations (McKnight and McKnight, 1993). Equation (1) shows the statistic for testing differences between two means of independent samples.

$$Z^* = \frac{(\overline{X}-\overline{Y})-(\mu_1-\mu_2)}{\sqrt{\frac{\sigma_1^2}{m}+\frac{\sigma_2^2}{n}}} \tag{1}$$

where $\overline{X}-\overline{Y}$ denotes the difference between the corresponding sample means; $\mu_1-\mu_2$ is the expected value of $\overline{X}-\overline{Y}$; σ_1 and σ_2 represent sample standard deviations, and m and n are sample populations.

Non-parametric tests (such as the Wilcoxon signed rank test, the Wilcoxon rank sum test, Mann-Whitney U test and Chi-squared test) are applied in cases where the requirement for normality was not met. The Wilcoxon signed rank test is a common nonparametric test for examining differences between two related samples (for example, the same group of drivers before and after DIP), while the Wilcoxon rank sum test, the Mann-Whitney U test and the Chi-squared test (Raub et al., 1999) are common nonparametric tests for examining differences between two mutually independent samples (for example, the experimental and control groups). Equation (2) shows the statistic of Wilcoxon rank sum test.

$$w = \sum_{i=1}^{m} r_i \tag{2}$$

where $\sum_{i=1}^{m} r_i$ denotes the sum of the ranks in the combined sample associated with i observations.

3.1.2 Survival Analysis

Survival analysis is usually applied to determine the period of time (number of days) during which the effects of the programs (such as driver improvement courses, advisory letters, warning letters, etc.) remain significant. Duration data are properly modeled with the use of estimation techniques that are based on hazard functions (Washington et al., 2003). Developing hazard-based duration models begins with the cumulative distribution function as shown in Equation (3):

$$F(t) = P(T < t) \tag{3}$$

Equation 3, for example, gives the probability of having a crash or violation before some transpired time, t. The density function corresponding to this distribution function (the first derivative of the cumulative distribution with respect to time) is as follows:

$$f(t) = dF(t)/dt \tag{4}$$

The corresponding hazard function is then in equation (5):

$$h(t) = f(t)/[1 - F(t)] \tag{5}$$

where h(t) is the conditional probability that an event will occur (for example an accident or death) between time t and t+dt, gives that the event has not occurred up to time t. The survivor function is shown in equation (6)

$$S(t) = P(T \geq t) \tag{6}$$

which provides the probability that a duration is greater than or equal to some specified time, t.

Cox proportional-hazards regression models are a category of survival models that recognizes that the effect of a treatment under study has a multiplicative effect on the subject's hazard rate. Jones (1997a; 1997b) discussed the influence from main effects (gender, age, control-treatment effect, letter type) on crash rates, moving violation rates or major violations rates, but also from interaction factors (eg. gender ×age, gender× age×

control-treatment). From the results of Cox regression survival analysis for accidents, both groups who received a letter had lower survival rates than the control groups (0.179, 1=no letter), but the differences were not consistent across gender (-0.3090, 1=female and no letter). Traffic accident-free survival figures: control and letter groups in female and male respectively, were also presented in the study, which shows the relationship between the number of months after treatment (receiving a letter) and the percentage of drivers who were not involved in a crash in each group, the higher the value the better.

Raub et al. (1999) also applied survival analysis to evaluate the effects of Traffic Survival School in Illinois in terms of percent reduction in tickets. Drivers in the control group were as likely to fail as those in the experimental group. A plot showing the relationship between days after class and percentage of drivers receiving tickets revealed that the experimental group was receiving tickets at a slower rate than the control group up to the first 120 days. This suggests that reinforcement for this group at between 90 and 120 days may prove helpful. (figure deleted)

3.1.3 Autoregressive Integrated Moving Average (ARIMA)

ARIMA models are fitted to time series data either to better understand the data or to predict future points in the series. They are applied in some cases where data show evidence of non-stationarity, where an initial differencing step (corresponding to the "integrated" part of the model) can be applied to remove the non-stationarity. DeYoung (2000) used this method to evaluate the general deterrent effect of vehicle impoundment on suspended and revoked drivers in California .The effects of an abrupt temporary intervention of vehicle impoundment was evaluated on crash rates between suspended/revoked drivers and validly licensed control drivers. The plots of the normalized crash series for suspended/revoked drivers and control drivers, respectively, showed that there is a strong downward trend in crashes for suspended/revoked drivers over the course of the study, and there is a visible abrupt drop in crashes at the 40th time period, corresponding to the effective date of the laws (vehicle impoundment/forfeiture). However, the crash rates of control drivers did not seem to trend upward or downward over the study period; there is an abrupt decline at the 40th time period but with a fairly quick upturn in the crash rates.

An *ARIMA model* was developed to test the effects of an intervention. Of the output of the model result, the omega term in the model represents the change in the level of the crash rate at the point in time that the vehicle impoundment/forfeiture laws were implemented. The negative omega value indicates that the crash rates for suspended/revoked drivers declined when the vehicle impoundment/forfeiture laws were implemented. The Delta term in the table describes how the crash rate subsequently changes over time. A small delta value, for example, would indicate that the crash rate returned quickly to the level it was at prior to the enactment of the vehicle impoundment/forfeiture laws—such an effect could be considered temporary.

3.1.4 Analysis of Covariance (ANCOVA)

ANCOVA is a general linear model with one continuous outcome variable (quantitative) and one or more factor variables (qualitative), which is a combination of Analysis of Variance (ANOVA) and regression for continuous variables. ANCOVA tests whether certain factors have an effect on the outcome variable after removing the variance for which quantitative predictors (covariates) account. The inclusion of covariates can increase statistical power because it accounts for some of the variability. ANCOVA models have been used by Deyoung (1999) to evaluate the effects of impoundment contained two factors (impound or control and labeled first or repeat offenders).

3.1.5 Probabilistic Models

*Binary probit model*s examine the likelihood of two discrete outcomes and have been often used to analyze the likelihood of crash involvement and/or convictions occurrence. Multinomial models are estimated to examine the likelihood of three or more discrete outcomes. Strathman et al. (2007) conducted a logit model to analyze the probability of being involved in one or more crashes or receiving one or more Type A conviction during 540-day period following suspension. Type A convictions includes moving violations, and Type B convictions are equipment and procedural violations. Five convictions for Type B violations counted as one conviction for a Type A violation. The model is specified as follows:

$$\mathbf{log}(\boldsymbol{P_i}/(\mathbf{1}-\boldsymbol{P_i}) = \boldsymbol{f}(\boldsymbol{Prior\ Crashes}, \boldsymbol{Prior\ Convictions}, \boldsymbol{Concentration}, \boldsymbol{Location}, \boldsymbol{Gender}, \boldsymbol{Age\ Group})$$

where *Pi* denotes the probability of being involved in one or more crashes, or receiving one or more Type A convictions during the540-day period following suspension. Other variables on the right-hand side are as follows: *Prior Crashes* include the number of recorded crashes that occurred during the 540-day period preceding suspension; *Prior Convictions* include the number of recorded Type A convictions received during the 540-day period preceding suspension; *Concentration* denotes the number of crashes and Type A convictions that occurred during the 540-day period preceding suspension, divided by the number of unique dates on which those offenses occurred; *Location* refers to a dummy variable being 1 if the subject's residence is located in an urban area, and 0 if the residence is located in a rural area; *Gender* is a dummy variable being 1 if the subject is male, and 0 if the subject is female; and *Age Group* denotes a series of dummy variables identifying the following age categories: 25-34 years; 35-44 years; 45-54 years; 55-64 years; 65-74 years; 75 years and older (with the 18-24 year age group serving as the reference category).

3.1.6 Count Data Models

Count data models are frequently used in transportation modeling for non-negative integer values, such as the number of driver route, changes per week, the number of trip departure changes per week, etc. Count data are properly modeled by using a number of methods, the most popular of which are Poisson and negative binomial regression models. One of the requirements for Poisson distribution is that the mean equals its variance. When the variance is significantly larger than the mean, the data are said to be overdispersed, and negative binomial models are used to model the overdispersed count data. A negative binomial regression model was developed by Gebers (2007) to analyze the frequency of one-year subsequent total crashes associated with Traffic Violation School in California.

3.2 Study Methodology

Based on the objectives of this study (outlined in Chapter 1), the likelihood of conviction occurrence after DIP and the frequency of subsequent conviction after DIP by gender and age are investigated. Binary probit models and count data models are the selected methodologies for this study.

3.1.2 Binary Probit Model

In modeling conviction occurrence after DIP, consideration was given to two possible discrete outcomes: whether a driver had a conviction or not during the first year after DIP. For two outcomes, the binary probit model defines a function that determines conviction occurrence as,

$$W_{in} = \beta_i x_{in} + \varepsilon_{in} \tag{7}$$

where W_{in} is the function that determines the probability of discrete outcome $_i$ for driver n, x_{in} is a vector of measurable characteristics (driver characteristics and history) that determine conviction occurrence for driver n, $_i$ is a vector of estimable coefficients, and $_{in}$ is an error term accounting for unobserved effects influencing the conviction occurrence outcome *i* for driver *n*.

It can be shown that if $_{in}$ are assumed to be normally distributed (McFadden 1981), then a standard binary probit model results, and the probability of outcome *i* is given a

$$P_n(i) = \frac{EXP[\beta_i x_i]}{1+EXP(\beta_i x_i)} \tag{8}$$

To assess the vector of estimated coefficients ($_i$), elasticities are estimated , which measure the magnitude of the impact of specific variables on the outcome probabilities. The elasticity is computed for each driver *n* (*n* subscripting omitted) as

$$E_{x_{ki}}^{P(i)} = \frac{\partial P(i)}{\partial x_{ki}} \times \frac{x_{ki}}{P(i)} \tag{9}$$

where is the probability of conviction outcome i and xki is the value of variable k for outcome i. Using Equation 8, Equation 9 gives

$$\mathrm{E}_{\mathrm{x_{ki}}}^{\mathrm{P(i)}} = [1 - \mathrm{P(i)}] \cdot \beta_{\mathrm{x_{ki}}} \cdot \mathrm{x_{ki}} \tag{10}$$

where β_{ki} is the estimated coefficient associated with variable x_{ki}. Elasticity values can be roughly interpreted as the percent effect that a 1% change in x_{ki} has on the convictions outcome probability P(i).

The pseudo-elasticity for indicator variables can be calculated as

$$E_{x_{ki}}^{P(i)} = \left[\frac{EXP(\beta_{ki})[1+EXP(\beta_i x_i)]}{1+EXP(\Delta\beta_i x_i)} - 1\right] \times 100 \qquad (11)$$

where $\Delta(\beta_i x_i)$ is the value of the function (see Equation 1) determining the crash injury severity level after x_{ki} has been changed from zero to one, and $\beta_i x_i$ is the value when x_{ki} = 0. The pseudo-elasticity of a variable with respect to a convictions outcome category represents the percent change in the probability of that conviction outcome when the variable is changed from zero to one.

In this study, binary probit model will be developed to model conviction occurrence after DIP, and consideration was given to two possible discrete outcomes: whether a driver had a conviction or not during the first year after DIP.

3.2.2 Count Data Model

The frequency of subsequent convictions is properly modeled using count data models, the most popular of which are Poisson and negative binomial regression models. One requirement of the Poisson distribution is that the mean of the count process equals its variance. When the variance is significantly larger than the mean, the data are said to be overdispersed, and can be properly modeled using a negative binomial model (Washington et al. 2003). In this study, the frequency of convictions subsequent to DIP was estimated using a negative binomial model (because overdispersion was present).

The negative binomial regression model is an extension of the Poisson regression model which allows the variance of the process to differ from the mean. For a non-negative integer variable, with observed frequencies, the probability of y_i (in this case, driver convictions) at i is given by:

$$P(y_i) = \frac{EXP(-\lambda_i)\lambda_i^{y_i}}{y_i!} \qquad (12)$$

where is the Poisson parameter for , which is equal to the expected frequency of driver convictions at i, $E[y_i]$. The log-linear model form used in this study to predict the expected number of convictions subsequent to DIP:

$$\ln(\lambda_i) = \beta_i \cdot x_i + \varepsilon_i \qquad (13)$$

where $EXP[\varepsilon_i]$follows a gamma distribution with mean 1.0 and variance α^2. This model has an additional parameter, α, which is often referred to as the overdispersion parameter, such that:

$$VAR[y_i] = E[y_i] \cdot [1+\alpha \cdot E[y_i]] \qquad (14)$$

To assess the vector of estimated coefficients(i), elasticities are estimated, which measure the magnitude of the impact of specific variables on the subsequent conviction frequency. The elasticity is computed for each driver n (n subscripting omitted) as

$$E_{x_{ki}}^{P(i)} = \frac{\partial P(i)}{\partial x_{ki}} \times \frac{x_{ki}}{P(i)} = \cdot\ \beta_{x_{ki}} \cdot x_{ki} \qquad (15)$$

where $\beta_{x_{ki}}$ is the estimated coefficient associated with variable x_{ki}. Elasticity values can be roughly interpreted as the percent effect that a 1% change in x_{ki} has on the subsequent conviction frequencyP(i).

That elasticity above is not applicable to indicator variables that take on values of 0 or 1. The pseudo-elasticity for indicator variables can represent the percent change on the subsequent conviction frequency when the variable is changed from zero to one and is computed as:

$$E_{x_{ki}}^{P(i)} = \frac{EXP(\beta_i) - 1}{EXP(\beta_i)} \times 100 \quad (16)$$

3.2.3 Association Rules

Association rules is a popular data mining method for discovering relations between variables in a large database, which was first introduced by Agrawal (Agrawal, et al., 1993). This method is widely used in market basket analysis (Berry and Linoff, 1997) to identify association rules among products purchased in supermarkets. For example, if a customer buys cereal (Event A), he or she is also 60 percent (representing the Confidence) more likely to buy milk (Event B), which will be of 10 percent (representing the Support) in all the transactions of supermarkets. Support represents the probability that event A (purchase of cereal) and event B (purchase of milk) occurred simultaneously (shown in Equation 17). Confidence represents the probability that event B (purchase of milk) occurred under the condition that event A (purchase of cereal) occurred (shown in Equation 18). The Lift value is the ratio between confidence (Equation 18) and the probability that event B (purchase of milk) occurred, and is estimated by Equation 19. According to (Giudici ,2003, Anand et al., 2006), if the Lift value is more than one, there exists a positive association between event A and event B occurrence; if lift value equals one, there is no association between occurrence of event A and event B; while if lift value is less than 1, there exists a negative association between event A and event B. If lift value equals zero, event B will never occur simultaneously with event A *(*Walpole and Myers, 1989*)*.

$$\text{Support} = P(A \cap B) = \frac{\text{number of records in the dataset in which both events A and B occured}}{\text{total number of records in the dataset}} \quad (17)$$

$$\text{Confidence} = \frac{\text{P(A∩B)}}{\text{P(A)}} = \frac{\text{support}}{\frac{\text{number of records in which event A occured}}{\text{total number of records in the dataset}}} \tag{18}$$

$$\text{Lift} = \frac{\text{confidence}}{\frac{\text{number of records in which event B occured}}{\text{total number of records in the dataset}}} = \frac{\text{P(A∩B)}}{\text{P(A)·P(B)}} \tag{19}$$

In this paper, due to the low variation in the subsequent number of crashes, association rules were applied in lieu of econometric models to examine how various driver characteristics are associated with crash occurrence within 12 months subsequent to DIP. To achieve this, we estimated the probability of a driver being involved in one crash within 12 months subsequent to DIP when event “A” occurs, to the general probability of a driver being involved in one crash within 12 months subsequent to DIP (event “B” will occur). The event “A” could represent male or female drivers, drivers in different age groups, and drivers’ conviction and crash history. The threshold values used in the analysis are 1% for support and 6% for confidence. It means that no rules with support lower than 1% and confidence lower than 6% would be considered, irrespective of their Lift values. A past study on the identification of accident circumstances that frequently occurred simultaneously (Geurts, K et al., 2005) used 5% as the threshold on support parameter, which is close to the values typically used in market basket analysis. However, due to the low crash occurrence and frequency within 12 months subsequent to DIP in our sample, the support for the rules of interest had to be set much lower. As such, the importance of the rules is also evaluated based on the Lift values. Note that a support value close to 1% was also used in an analysis of non-intersection crash data in Florida (Pande and Abdel-Aty, 2009).

3.3 Summary

In this chapter, methodologies applied in previous studies were summarized and examples of each method were presented. Based on the review of these previous studies, the methodology for this study was selected. In general, statistical analysis plays an essential role in evaluation of driver improvement program. Statistical tests (parametric or nonparametric tests) are conducted first to compare the mean crashes, crash rates or violation rates between the control and experimental group, and a model is then developed to further study the effect of independent variables and interaction factors on the treatment (vehicle impoundment/forfeiture, advisory letters, license suspension, etc). Based on the objectives of this study, binary probit model and count data model will be developed to estimate the probability of conviction occurrence and frequency of conviction involvement after DIP.

CHAPTER 4. DATA COLLECTION AND DESCRIPTIVE ANALYSIS

4.1 Overview

This chapter represents data descriptive analysis for the data on drivers who were instructed to attend DIP provided by the Motor Vehicle Division. The data are summarized and interpreted using descriptive analysis techniques and graphical representations.

4.2 Descriptive Analysis

A random sample of driving records of drivers who were instructed to attend DIP was provided by the Motor Vehicle Division. The database includes driver and action-specific information. Driver-specific information includes gender, age, license class, date sent to DIP, location of DIP, and DIP outcome (satisfactory or unsatisfactory completion). Action-specific information included the action type, reason code, driver PID number, actual speed, posted speed limit, jurisdiction and crash case number.

Drivers are divided into two groups based on the DIP outcome (satisfactory or unsatisfactory completion). The “satisfactory” group consists of drivers, who successfully completed the driver improvement program course. The “unsatisfactory” group consists of drivers, who did not complete or did not attend DIP after they received the letter. The DIP date refers to the date when drivers were instructed to attend DIP. Actions types are categorized into DOT actions or sanctions (suspension, disqualified, and revoked license) and driver actions (convictions and crashes). It should be noted that the license of the drivers in the “unsatisfactory” group would be suspended after the DIP date, the license of the drivers in the “satisfactory” group would be suspended after DIP upon their first conviction within 12 months.

4.2.1 Driver-specific Information

Figure 4.1 shows that most of the drivers in our sample were sent to DIP from 2006 to 2008 (a total of 12,354 drivers).

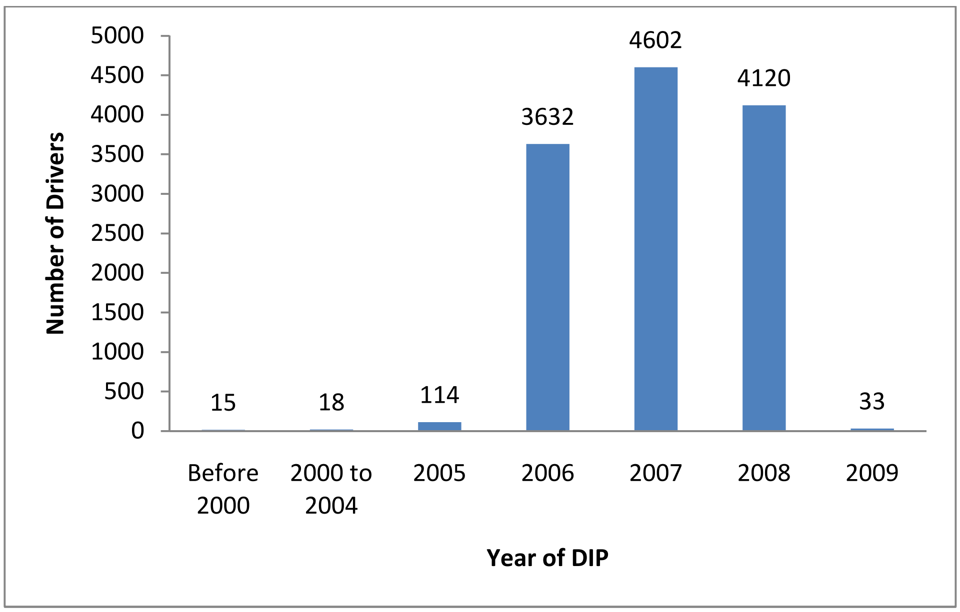

Figure 4.1. Number of drivers by year of DIP

Our sample size was further reduced to *9, 055 drivers* because we considered only the drivers who own a Class C license and only the drivers, for whom there was complete information on their gender, age, location of DIP, and DIP outcome. As such, the total number of DIP participants in the final sample is 2,746 (30%) in 2006, 3,373 (37%) in 2007 and 2,936 (33%) in 2008.

Figure 4.2 shows the geographical distribution of the 17 community colleges in Iowa. It can be observed that they are well-dispersed across the State. The community college names and abbreviations are listed in Table B.1 in Appendix B.

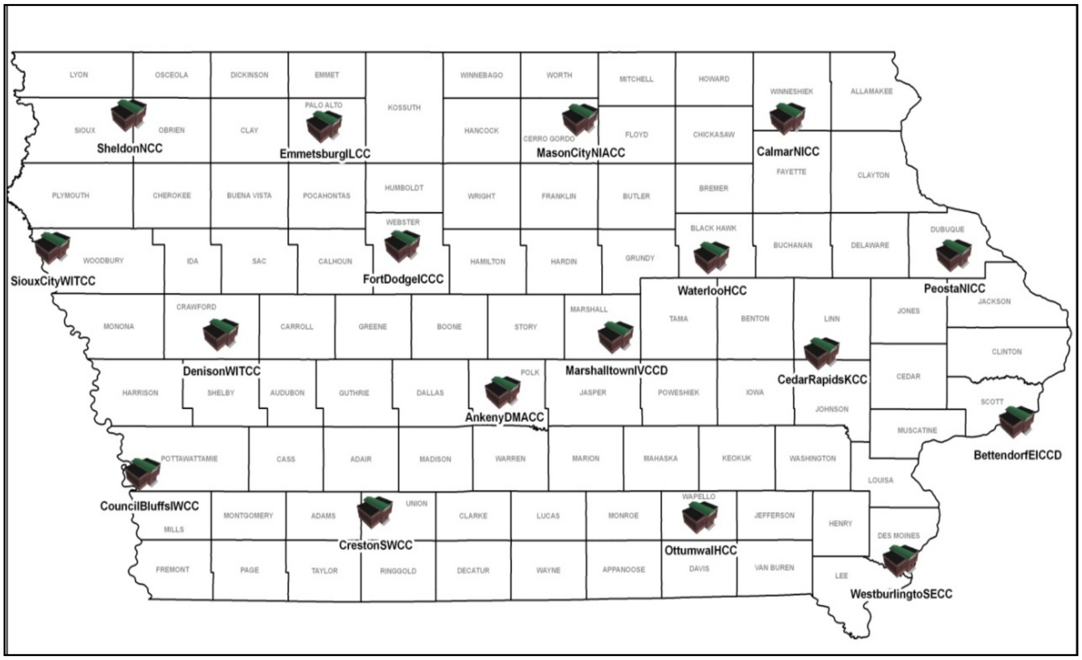

Figure 4.2. 17 Driver improvement program sites in Iowa.

Figure 4.3 shows the distribution of driver population by year in the 17 community colleges, which offer DIP. The Des Moines Area Community College (DMACC), Eastern Iowa Community College District (EICCD) and Kirkwood Community College (KCC) are the top three colleges, which have the highest DIP participation rates. The distribution of driver population by DIP date in the 17 community colleges is shown in Appendix C.

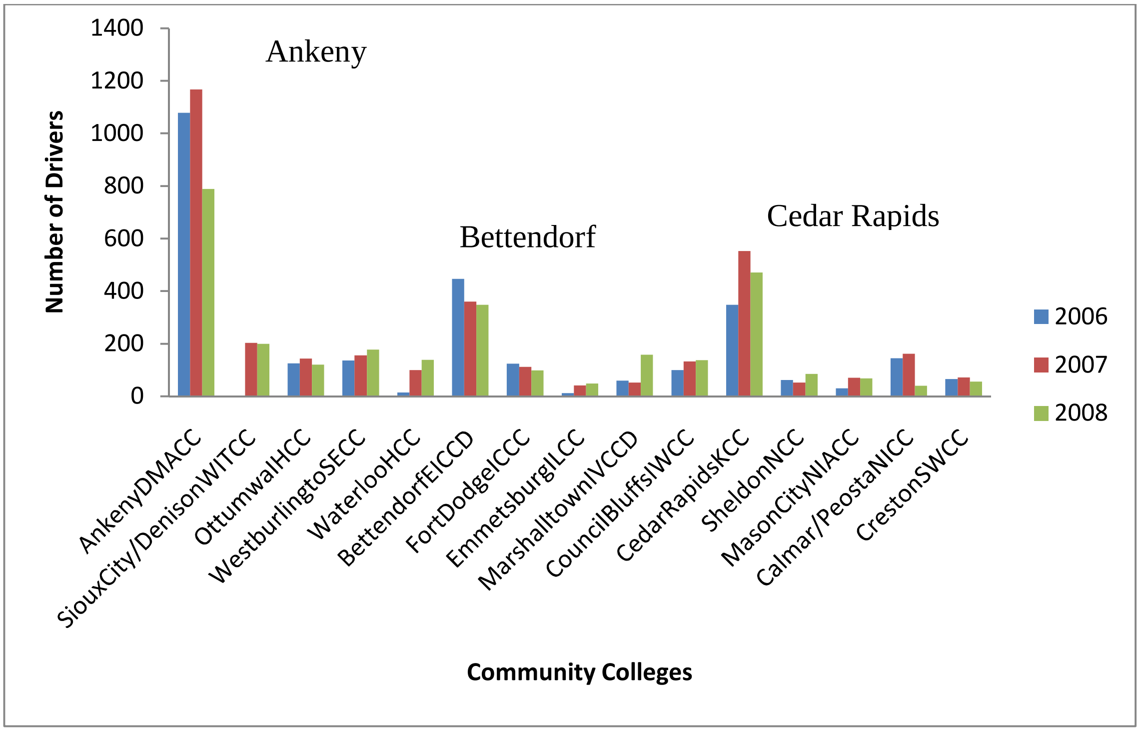

Figure 4.3. Number of drivers by DIP location, 2006 to 2008.

4.2.2 Action-specific Information

Actions types are categorized into DOT actions (suspension, disqualified, and revoked license) and driver actions (convictions and crashes). Table B.2 in Appendix B shows the different reasons of a conviction; for example, reason code 12 refers to driving while holding a suspended, denied, cancelled or revoked license. Drivers, who were convicted for speed limit violation (reason code 72), exceeded the speed limit by 13.7 miles per hour (standard deviation of 6.2 miles per hour) on average.

4.2.2.1 Actions before DIP

Table 4.1 shows the distribution of all the actions before DIP by year. It can be seen that most actions can be tracked four years before the DIP date.

Table 4.1. Distribution of all the actions before DIP by year

Year	<0	1	2	3	4	5	>5
Number of Actions	1,303	32,113	10,940	5,228	1,139	250	982

4.2.2.2 Actions after DIP

Table 4.2 shows the distribution of all the actions after DIP by month group. It is of interest to examine the effectiveness of the program *within the probation period* (one year after date sent to DIP) when Table 4.2 shows that most actions occur. The period from 13th month to 18th month after DIP date will also be analyzed in the descriptive analysis section.

Table 4.2. Distribution of all the actions after DIP by month group

Month Group	<0	0-12	13-18	18-24	25-36	>37
Number of Actions	906	9,761	1,598	1,024	962	102

4.2.2.3 Summary statistics

Table 4.3 and Table 4.4 show the summary statistics for the driver- and action-specific variables in the final sample.

Table 4.3 Summary statistics of variables by gender

	Mean (standard deviation) or Percentage	
Variables	**Female**	**Male**
Community Colleges DMACC / EICCD / KCC / Other	33.2 / 13.3 / 16.1 / 37.4	33.7 / 12.4 / 14.6 / 39.3
Age 30 or younger/31-40/40or older	32.0 (11.5) 58.9 /19.9/21.2	32.7 (12.6) 56.6/19.4/24.0
Number of Convictions before DIP 1 / 2 / 3 / 4 / 5 /Other	3.45 (1.57) 12.1/8.4/33.7/23.3/ /12.9/9.7	3.56 (1.58) 10.4/8.1/27.9/23.2/ /12.9/17.5
Number of Crashes before DIP 0 / 1 /2/Other	0.41(0.68) 67.2/26.1/5.1/1.5	0.37 (0.64) 70.5/23.4/5.1/1
DIP Outcome Satisfactory / Unsatisfactory	75.0 / 25.0	75.0 / 25.0
Number of Convictions within 12 months after DIP	0.29 (0.66)	0.32 (0.67)
Number of Crashes within 12 months after DIP	0.07 (0.26)	0.06 (0.26)
Number of Convictions from 13th to 18th month after DIP	0.07 (0.32)	0.08 (0.34)
Number of Crashes from 13th to 18th month after DIP	0.02 (0.12)	0.02 (0.13)
Number of Days after DIP until the first conviction	208.5 (141.8)	194.3 (142.8)
Number of Days after DIP until the first crash	208.8 (143.9)	216.4 (145.4)

Table 4.4 Summary statistics of variables by age

	Mean (standard deviation) or Percentage		
Variables	**Age≤30**	**Age 30-40**	**Age>40**
Community Colleges DMACC / EICCD / KCC /Other	32.9 / 12.9 / 15.4 / 38.7	34.3 / 14.0 / 14.0 / 37.8	34.4 / 11.2 / 13.6 /40.7
Age 30 or younger/31-40/40or older	24.0 (3.07)	35.1 (2.9)	51 (9.3)
Number of Convictions before DIP 1 / 2 / 3 / 4 / 5 /Other	3.52 (1.58) 10.6/9.1/32.9/ 23.1/ /13.5/10.8	3.59 (1.55) 10.3/8.3/33.7/ 24.1/ /12.4/11.2	3.46 (1.58) 12.6/9.9/33.0/ 22.7/ /11.8/10.1
Number of Crashes before DIP 0 / 1 /2/Other	0.45(0.69) 64.7/27.5/6.5/1.3	0.29 (0.57) 76/19.9/3.3/0.8	0.31 (0.62) 75.2/20.2/3.3/ 1.3
DIP Outcome Satisfactory /Unsatisfactory	73.1 / 26.9	73.4 / 26.6	81.1 / 18.9
Number of Convictions within 12 months after DIP	0.35 (0.70)	0.28 (0.65)	0.23 (0.57)
Number of Crashes within 12 months after DIP	0.07 (0.28)	0.06 (0.24)	0.05 (0.23)
Number of Convictions from 13th to 18th month after DIP	0.08 (0.34)	0.09 (0.33)	0.07 (0.32)
Number of Crashes from 13th to 18th month after DIP	0.02 (0.13)	0.02 (0.13)	0.01 (0.01)
Number of Days after DIP until the first conviction	188.1 (139.2)	215.8 (148.5)	218.7 (144.3)
Number of Days after DIP until the first crash	210.1 (142.5)	235.6 (147.4)	204.2 (149.3)

4.3 Interaction Analysis

4.3.1 Gender and DIP Outcome

Figure 4.4 shows the distribution of drivers by gender and DIP outcome. The percentages of female and male drivers are the same in both groups (U and S)—36% and 64%, respectively. This suggests that there was no observed difference between male and female drivers with respect to DIP outcome (satisfactory or unsatisfactory). Chapter 5 will present an econometric approach to examine further the gender and DIP outcome interactions.

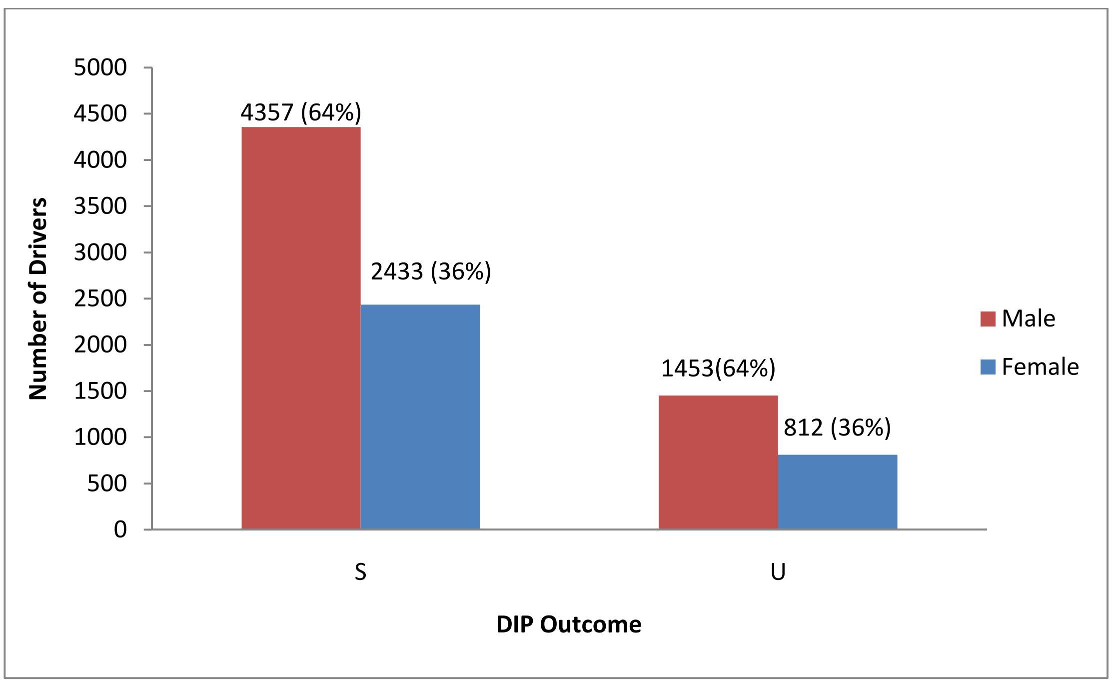

Figure 4.4. Number of drivers by gender and DIP outcome

4.3.2 Age and DIP Outcome

Figure 4.5 shows the distribution of drivers by age and DIP outcome. The percentages of three age group drivers are not the same in S and U group, which suggests there might be small differences between three age group drivers with respect to DIP outcome (satisfactory or unsatisfactory). It should be noted that drivers younger than 21 years old (6.5% of all drivers) were placed in the same group with drivers between 21 and 30 years old, and drivers were older than 51 years old (9.6%) were placed in the same group with drivers between 41 and 50 years old, as those two groups represented less than 10% of the total number of observations.

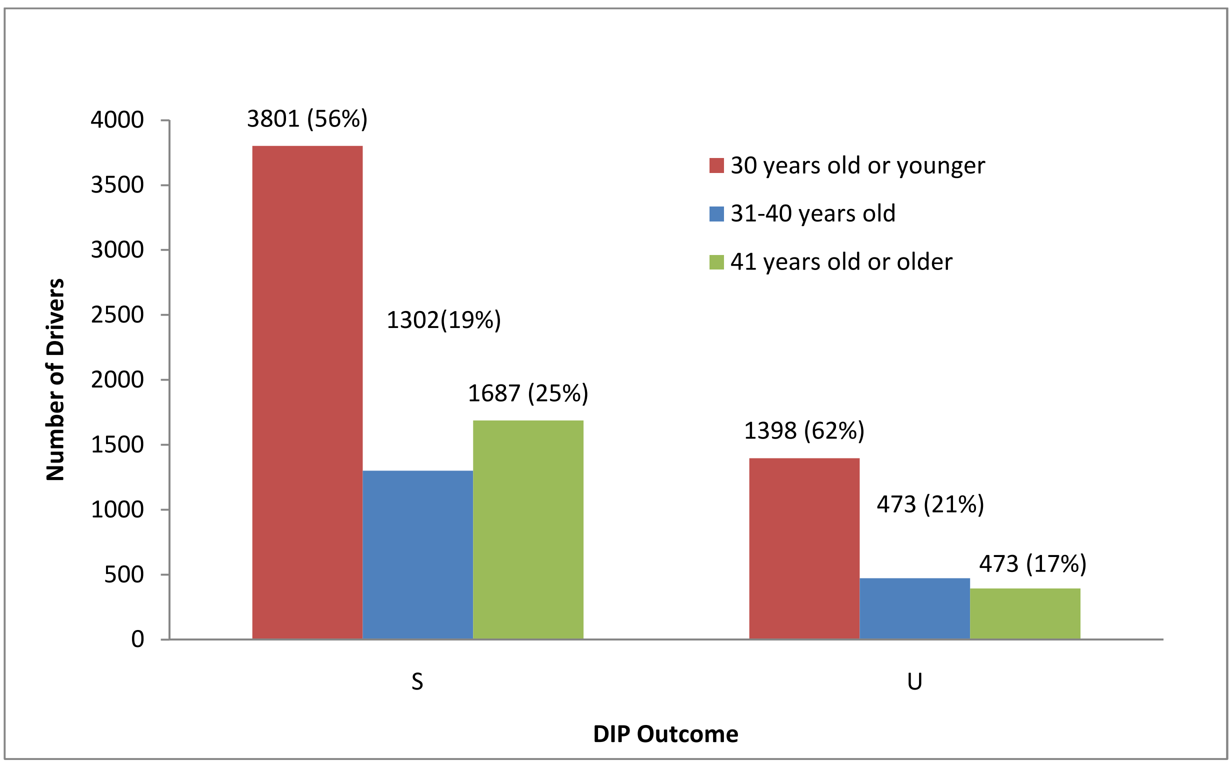

Figure 4.5. Number of drivers by age and DIP outcome

4.3.3 Age, Gender and DIP Outcome

Table 4.5 shows the distribution of drivers by age, gender and DIP outcome. Male drivers were overrepresented in the 41 year old or older-group, and underrepresented in the 30 year old or younger-group.

Table 4.5. Number of drivers by age, gender and DIP outcome

	Satisfactory Group				**Unsatisfactory Group**			
	male	*female*	*total*	***M/F *ratio***	*male*	*female*	*total*	***M/F *ratio***
30 years old or younger	**2397**	**1404**	**3801**	**1.76**	**892**	**506**	**1398**	**1.67**
31-40 years old	824	478	1302	**1.80**	304	169	473	**1.72**
41 years old or older	1136	551	1687	**1.88**	257	137	394	**2.06**
Total	4,357	2,433	6,790	**1.79**	1,453	812	2,265	**1.79**

* Male to female ratio

4.3.4 Driver Convictions/Crashes and DIP Outcome Distribution

Among the total 9,055 DIP participants, 6,790 (75%, S) drivers completed the course satisfactorily, while 2,265 (25%, U) drivers were included in the "unsatisfactory" group. Among the 6,790 drivers in the "satisfactory" group, 4,946 (73%, S_0) drivers had no actions within 12 months after DIP. S_1 represents drivers who had actions after DIP, and would have their license suspended upon their first conviction during the probation period. U represents drivers in unsatisfactory group who would be suspended after the DIP date, because of failure to complete or attend the course. As such, it is anticipated that the number of actions for suspended drivers would drop significantly during the suspension period, compared to the driver population. Figure 4.6 represents the population and percentages of each three groups. This finding provides preliminary evidence of the significance of the DIP program in reducing subsequent actions. It should be noted that only 7% of DIP participants were involved in a crash within 12 months after the DIP date, and only 2% of DIP participants were involved in a crash during the period from 13 to 18 months after DIP.

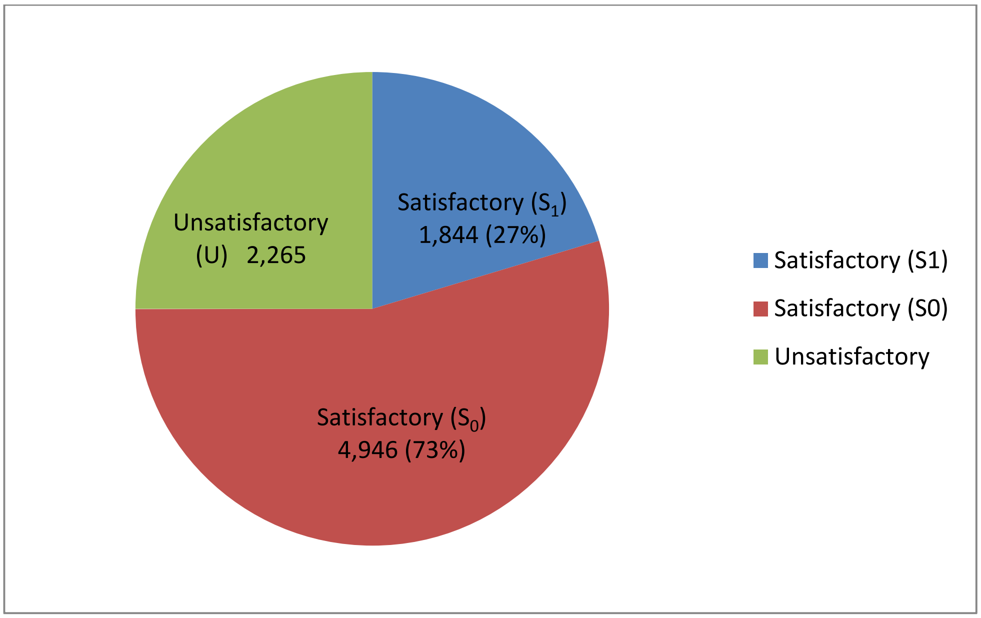

Figure 4.6 Distribution of drivers by DIP outcome and subsequent driver convictions/crashes

4.3.4.1 Driver convictions/crashes and DIP outcome distribution by gender

Table 4.6 shows the average number of convictions/crashes per 100 drivers per month by gender and DIP outcome. Figures 4.7-4.10 show the number of convictions/crashes per 100 drivers over the 18-month period subsequent to DIP by gender and DIP outcome. Trend lines were plotted and an equation was estimated to show the trend of convictions and crashes. R squared valued are also presented along the trend line. R squared value represents the goodness of fit of the trend line, the higher the number the better the fit (maximum R^2=1).

In cases where the goodness of fit was not satisfactory (very low R squared number), trend lines are not shown.

As shown in Table 4.6, male drivers had more convictions but fewer crashes than female drivers before DIP. After DIP, male drivers still had more convictions, especially within the first 6 months (S-Group) (Figure 4.7). Female drivers were involved in more crashes than male drivers after DIP, especially during the probation period (Figure 4.8). Both male and female drivers in the satisfactory group incurred lower number of convictions, while there is no significant difference in the number of crashes between the satisfactory and unsatisfactory groups. Moreover, the trend lines suggest that male drivers still tend to have more convictions than female in both S and U groups, and higher number of crashes than female in the satisfactory group after 15 months subsequent to DIP.

Table 4.6 Number of convictions/crashes per 100 drivers per month by gender and DIP outcome

			Before DIP		**After DIP**
DIP Outcome	Gender	Convictions per 100 drivers per month	Crashes per 100 drivers per month	Convictions per 100 drivers per month	Crashes per 100 drivers per month
Satisfactory	Male	7.34	0.77	2.09	0.48
	Female	7.05	0.86	1.89	0.50
Unsatisfactory	Male	7.67	0.78	2.72	0.36
	Female	7.57	0.86	2.49	0.37

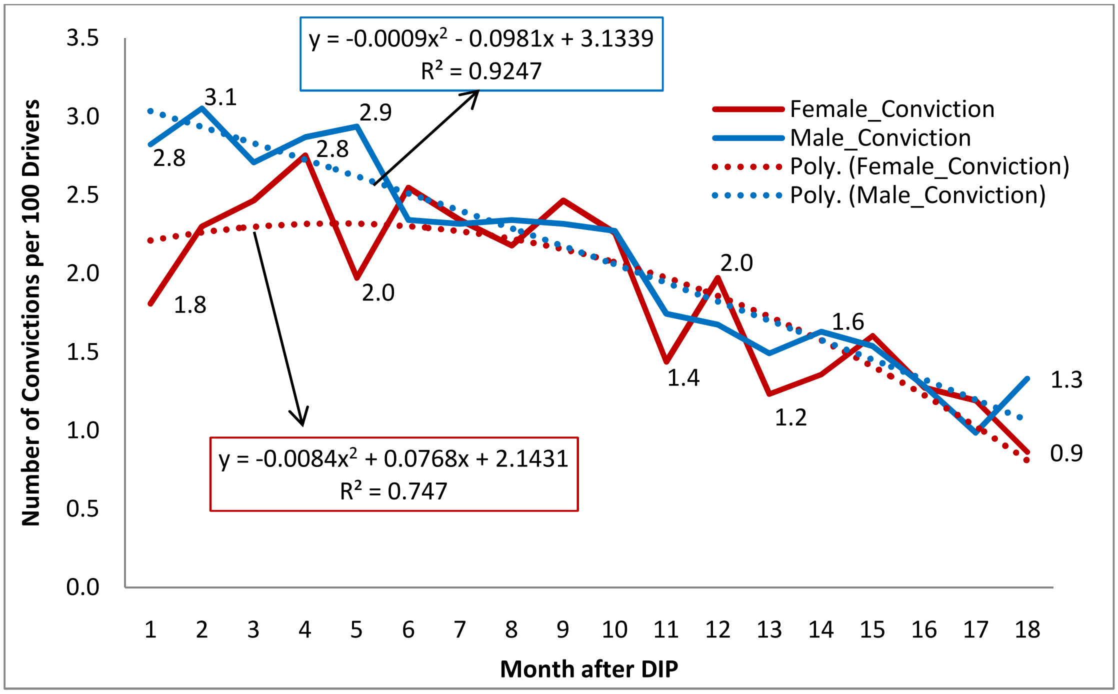

Figure 4.7 Number of convictions per 100 drivers in the S-group by gender over 18 months subsequent to DIP

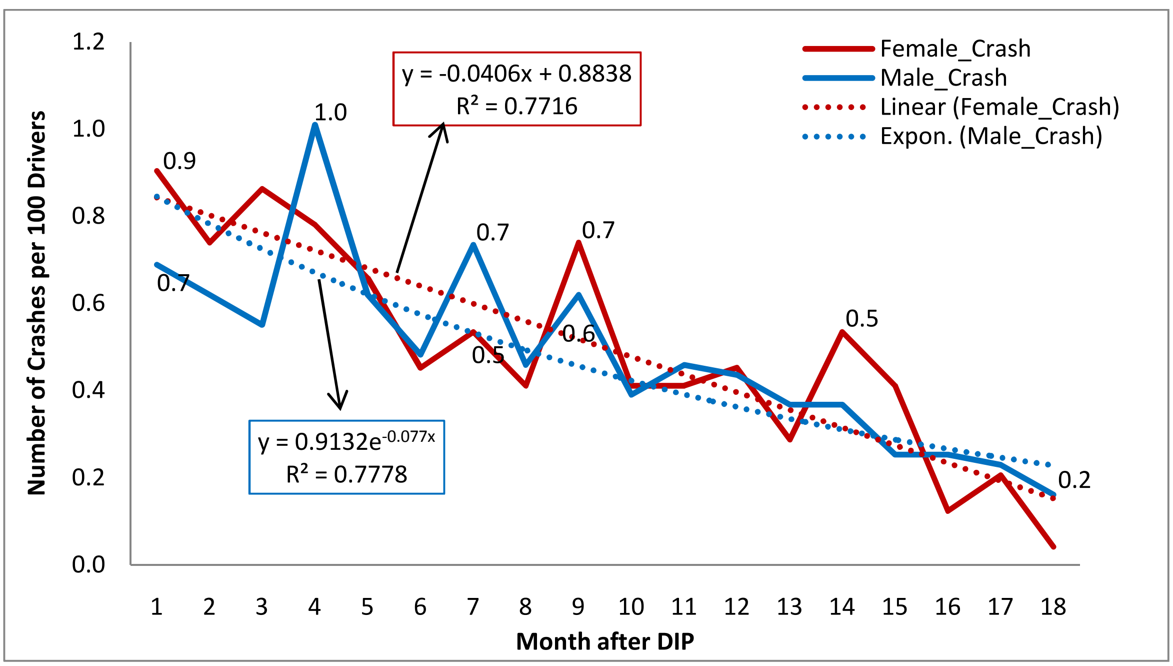

Figure 4.8 Number of crashes per 100 drivers in the S-Group by gender over 18 months

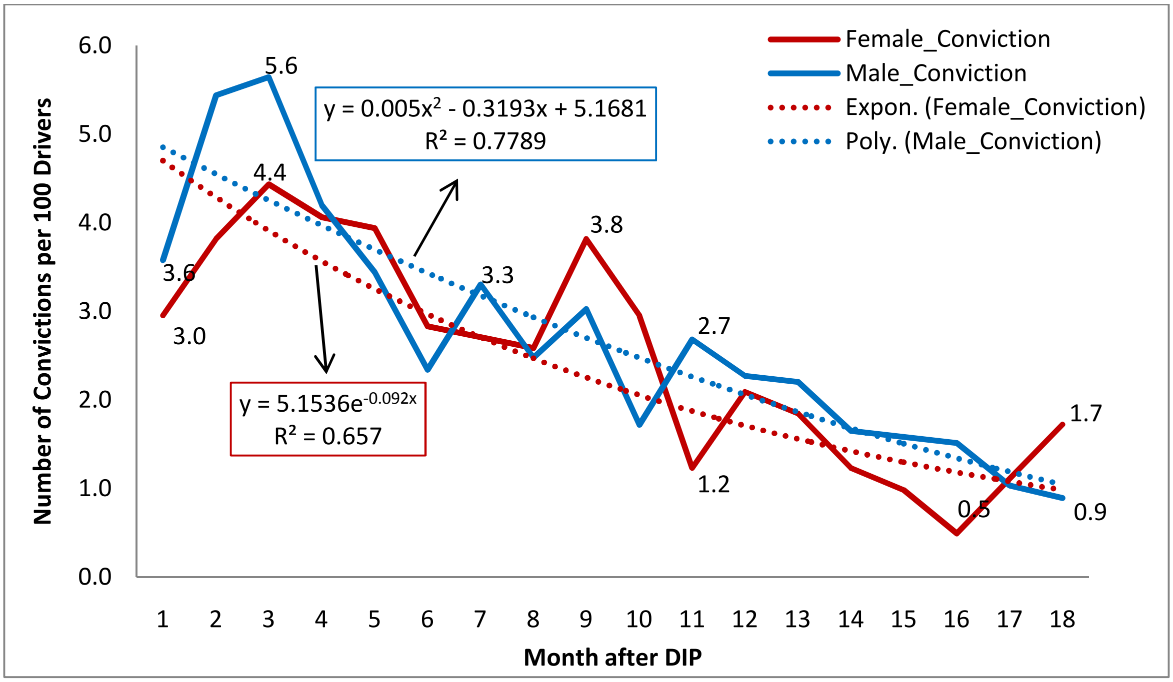

Figure 4.9 Number of convictions per 100 drivers in the U-Group by gender over 18 months

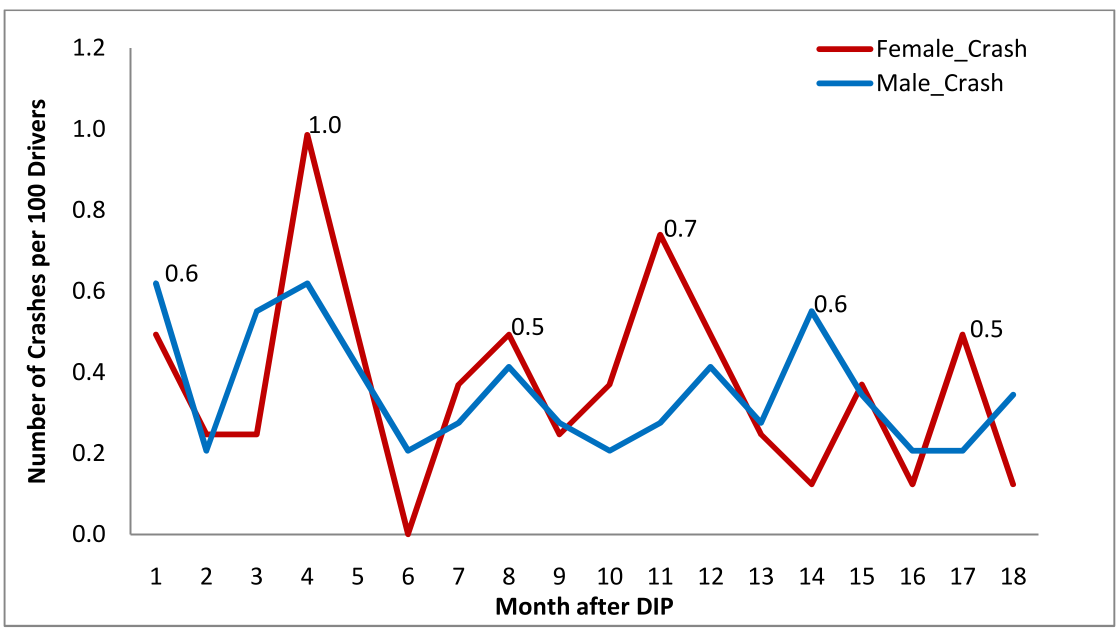

Figure 4.10 Number of crashes per 100 drivers in the U-Group by gender over 18 months

4.3.4.2 Driver convictions/crashes and DIP outcome distribution by age

Table 4.7 shows the number of convictions/crashes per 100 drivers per month by age and DIP outcome. Figures 4.11-4.14 show the number of convictions/crashes per 100 drivers over the 18-month period subsequent to DIP by age and DIP outcome. Trend lines were plotted and an equation was estimated to show the trend of convictions and crashes. R squared valued are also presented along the trend line.

As shown in Table 4.7, young drivers (30 years of age or younger) incurred a higher number of convictions and crashes than older drivers (41 years of age or older) in both the S and U groups before DIP. After DIP, the number of convictions decreases with increasing age in both the outcome groups. However, as shown in Figures 4.11 and 4.13, the differences between the three age groups became smaller after 6 months. Young drivers (40 years of age or younger) had more crashes than the older drivers, and the differences lasts over 18 months subsequent to DIP. Turning to the DIP outcome, drivers of all ages who completed DIP satisfactorily incurred fewer convictions than the drivers who did not attend or complete DIP, The difference in the number of crashes is less pronounced between the satisfactory and unsatisfactory group. Moreover, the trend lines suggest that younger drivers will incur fewer convictions after the 18-month period subsequent to DIP.

Table 4.7 Number of convictions/crashes per 100 Drivers per Month by Age and DIP Outcome

DIP Outcome	Age	Before DIP Convictions per 100drivers per month	Before DIP Crashes per 100drivers per month	After DIP Convictions per 100drivers per month	After DIP Crashes per 100 drivers per month
Satisfactory	**Age<=30**	7.21	0.96	2.3	0.6
	30<Age<=40	7.39	0.60	1.8	0.4
	Age>40	7.19	0.61	1.6	0.4
Unsatisfactory	**Age<=30**	7.71	0.87	2.8	0.4
	30<Age<=40	7.71	0.60	2.6	0.5
	Age>40	7.29	0.82	2.2	0.2

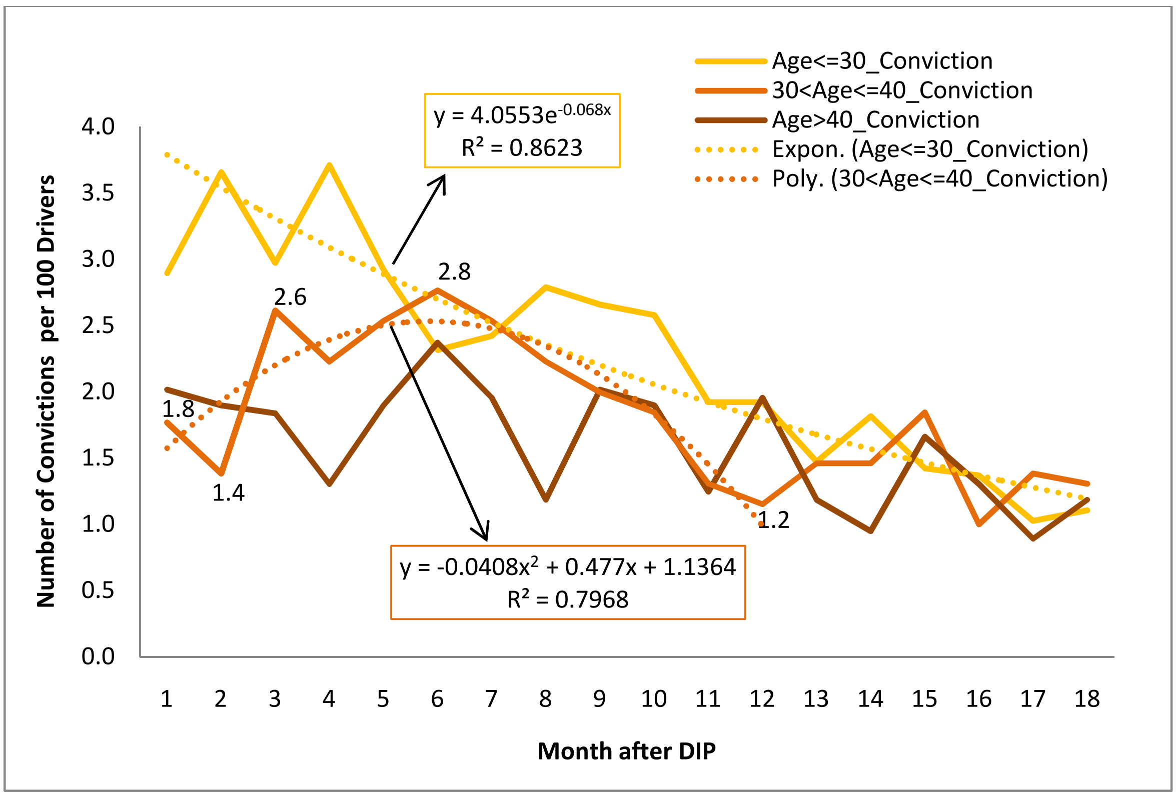

Figure 4.11 Number of convictions per 100 drivers in the S-Group by age over 18 months

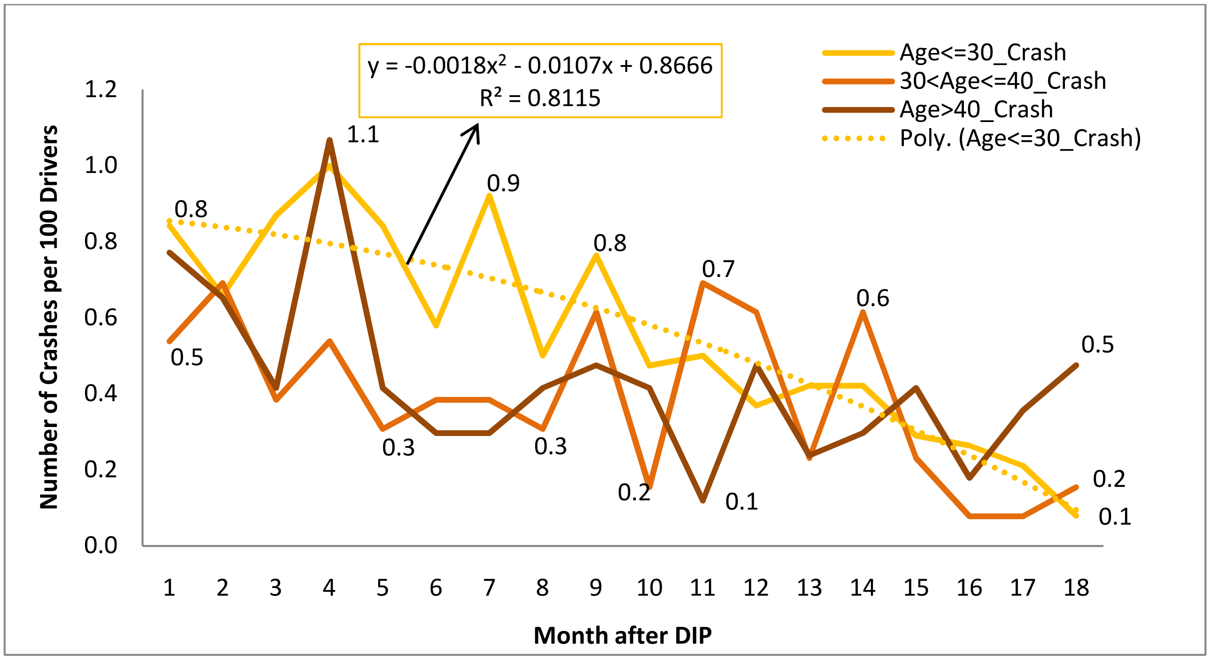

Figure 4.12 Number of crashes per 100 drivers in the S-Group by gender over 18 months

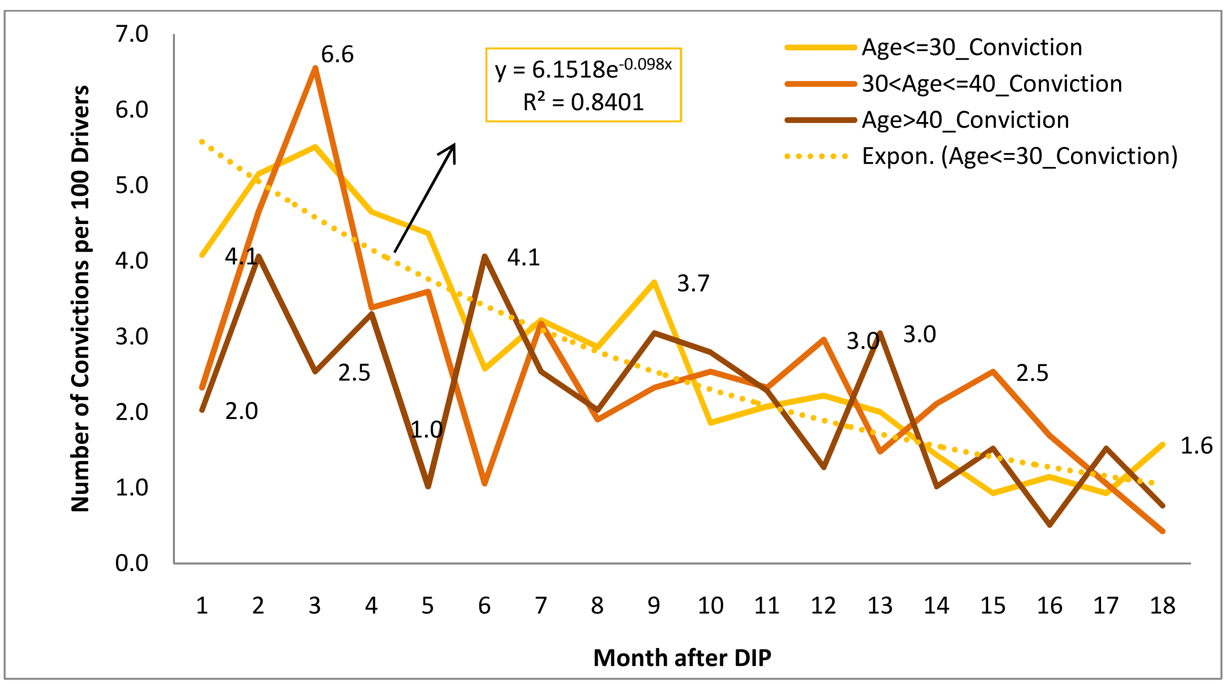

Figure 4.13 Number of convictions per 100 drivers in the U-Group by gender over 18 months

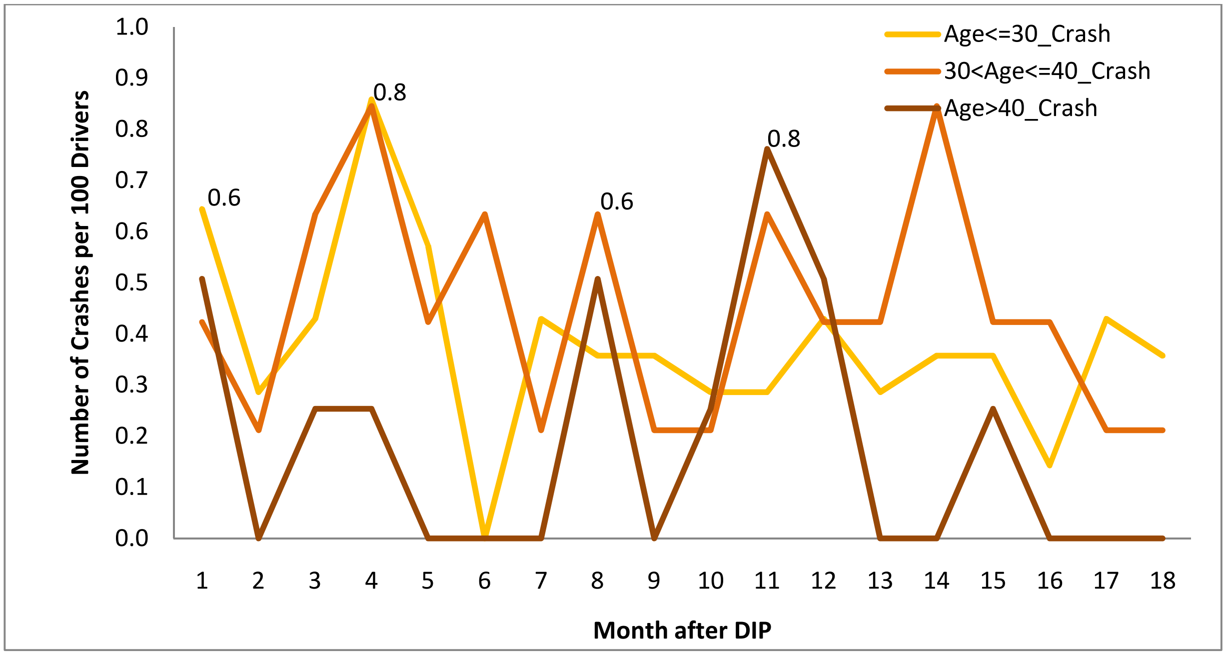

Figure 4.14 Number of crashes per 100 drivers in the U-Group by gender over 18 months

In summary, male drivers and young drivers (30 years of age or younger) incurred more convictions, while older drivers (40 years of age or older) had fewer crashes in both the satisfactory and unsatisfactory groups. Drivers in the satisfactory groups had lower conviction rates but more crashes than unsatisfactory group. The number of convictions and crashes decreased over 18 months subsequent to DIP, especially during the 13^{th} to 18^{th} month- period, which could attributed to the effectiveness of DIP or suspension.

4.3.5 Citation Type and DIP Outcome

Figure 4.14 and Figure 4.15 show the percentage of citations by citation type and gender for the S and U groups, respectively. Figure 4.16 and Figure 4.17 show the percentage of citations by citation type and age for the S and U groups, respectively. It is shown that the same types of violations led the drivers in both groups (U and S) to attend DIP, with speeding being the most common reason. During the 18 month-period after DIP, speeding is still the major reason for a citation, but more drivers were convicted of speeding less than 10 miles over speed limit in 35 to 55 mph zones. No drivers' license and driving while suspended become frequent reasons (after speeding) for receiving a citation after DIP, especially for the U group.

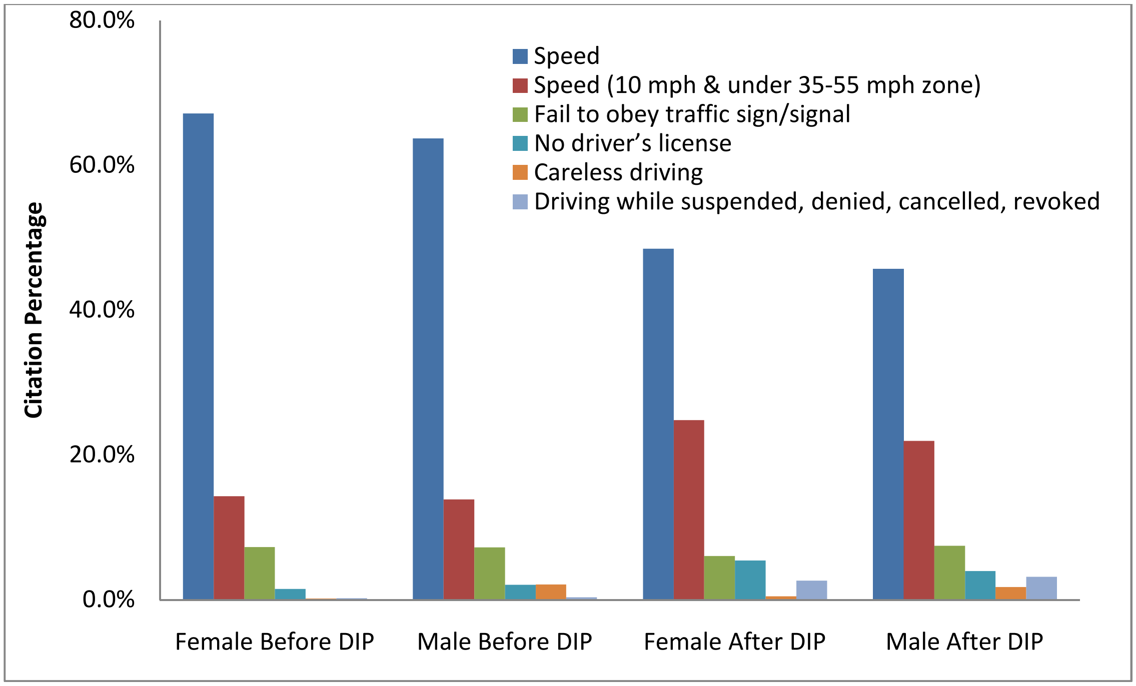

Figure 4.15. Percentage of citations by citation type and gender -S Group

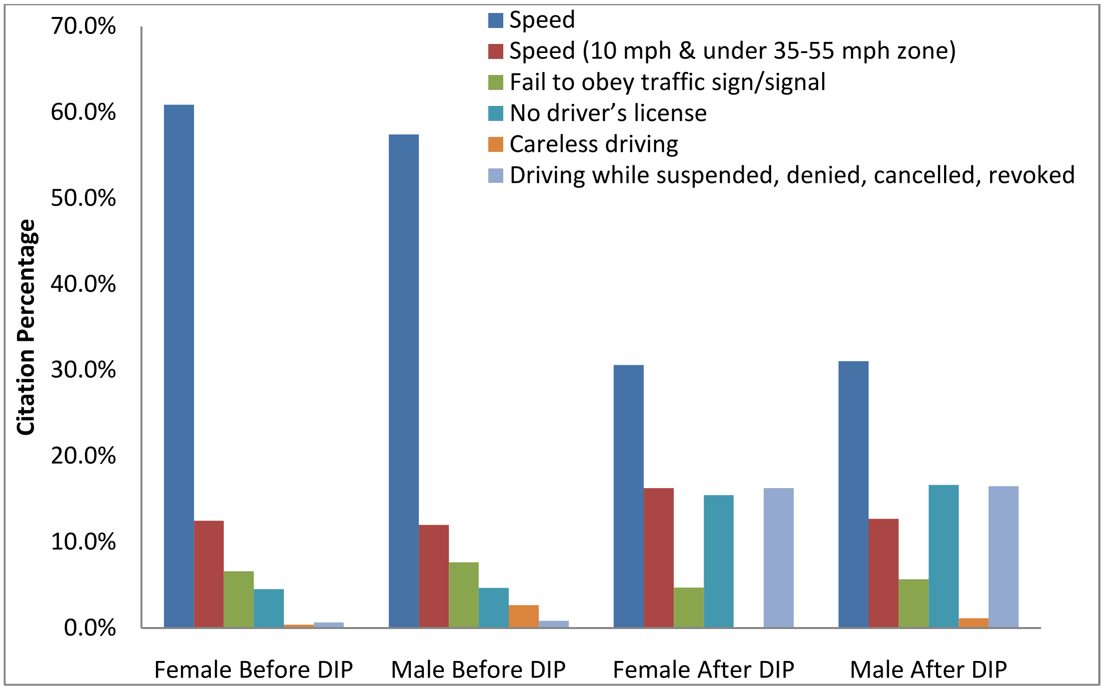

Figure 4.16. Percentage of citations by citation type and gender -U Group

Comparing the differences in citation type by gender, careless driving was a more frequent type of citation for male than female drivers. It is interesting to find that driving with no driver's license was a more frequent offense for female drivers who completed DIP than their male counterparts, but the opposite trend applied for those in the unsatisfactory group. Lastly, female drivers did not incur as many convictions as male drivers for failure to obey traffic sign/signal in both groups (U and S).

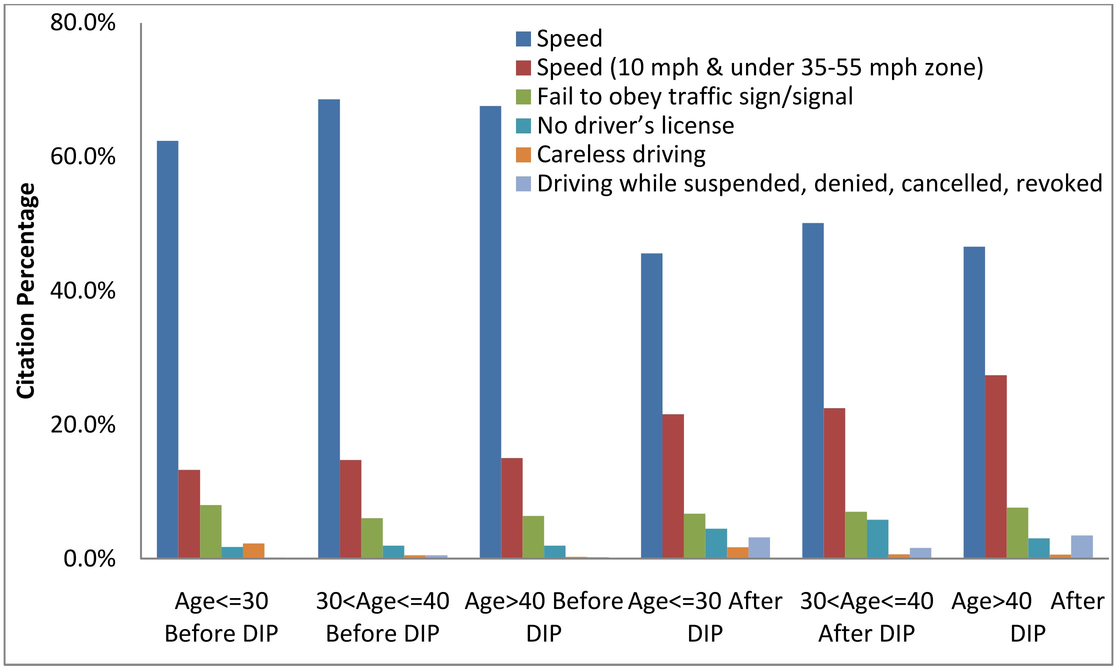

Figure 4.17. Percentage of citations by citation type and age -S Group

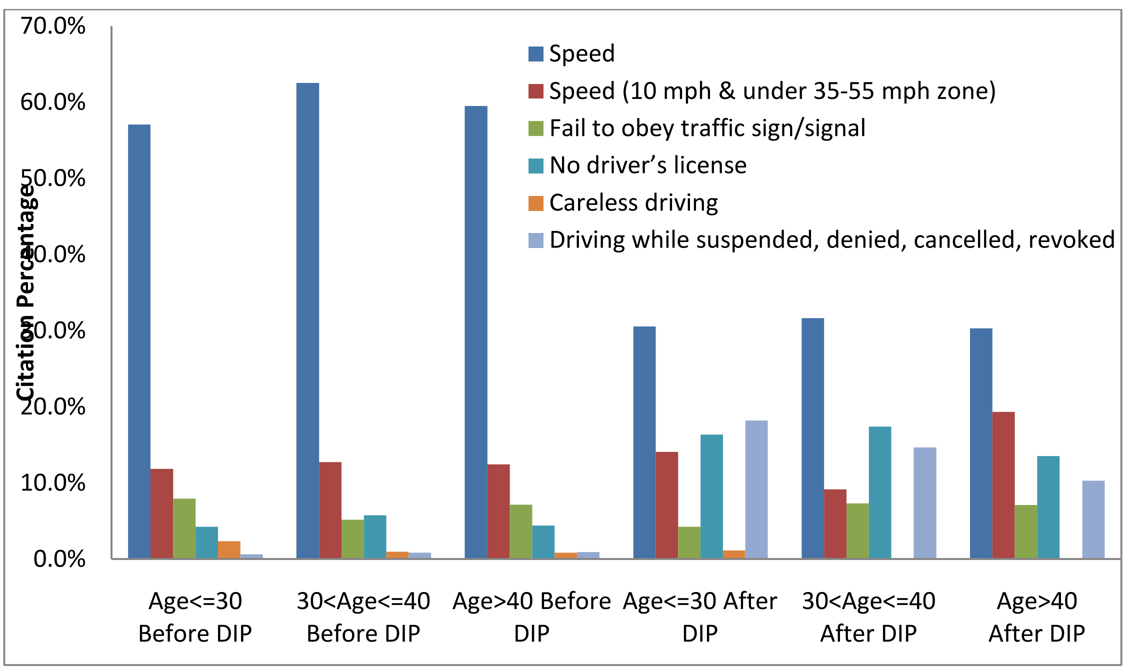

Figure 4.18. Percentage of citations by citation type and age -U Group

Comparing the differences in citation type by age, drivers who are 30 years old or younger had a much higher percentage of careless driving, than older drivers both before and after DIP. It is also found that drivers younger than 40 years of age had a lot higher conviction percentage of driving without a driver's license present and driving while suspended than the older drivers (older than 40 years of age) in the unsatisfactory group after DIP. However, it is interesting to note that young drivers (30 years of age or younger) did better in obeying traffic sign/signal than the other two age groups in the U group.

In general, speeding is the major reason for a citation, followed by speeding less than 10 mph over the posted speed limit in 35-55 mph zones, driving with no driver's license, and driving while suspended. It is recommended that DIP instruction focus on these types of citations. Careless driving and obeying traffic sign/signal should be emphasized in DIP instruction materials towards men, young drivers (30 years of age or younger) and older drivers (40 years or older).

4.3.6 Days of First Conviction and Crash Subsequent to DIP

Figures 4.19 and 4.20 show the number of days until drivers' first conviction or crash by gender and outcome over 18 months after DIP, and corresponding percentages. It is shown that most drivers have their first conviction within 90 days after DIP and the percentages drop gradually thereafter. A higher percentage of male drivers incurred their first conviction in first 135 days after DIP than female drivers; however, the differences become smaller after that. While there is a decreasing trend in conviction occurrence over time, crashes do not follow any particular trend but rather are more concentrated in certain time periods, including during the first 135 days, period between 180 and 225 days, and last 45 days of the probation period. It can be also observed that more drivers in the satisfactory group were involved in their first crash within the first 135 days after DIP, and female and male drives were involved in almost the same percentage.

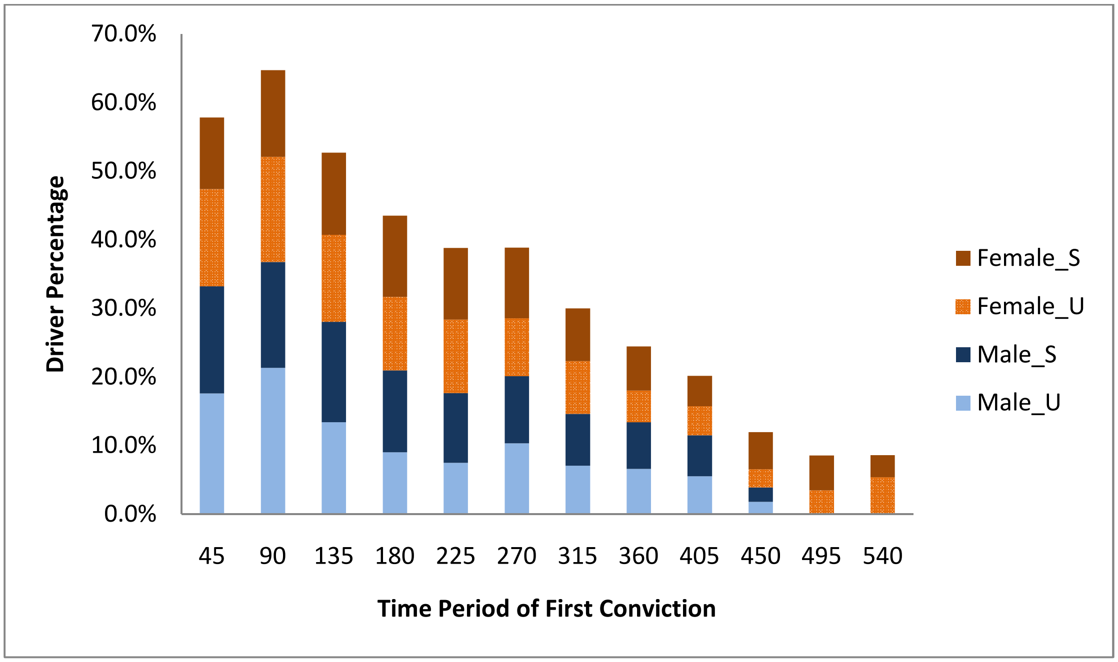

Figure 4.19 Days of first conviction by gender and outcome over 18 months after DIP

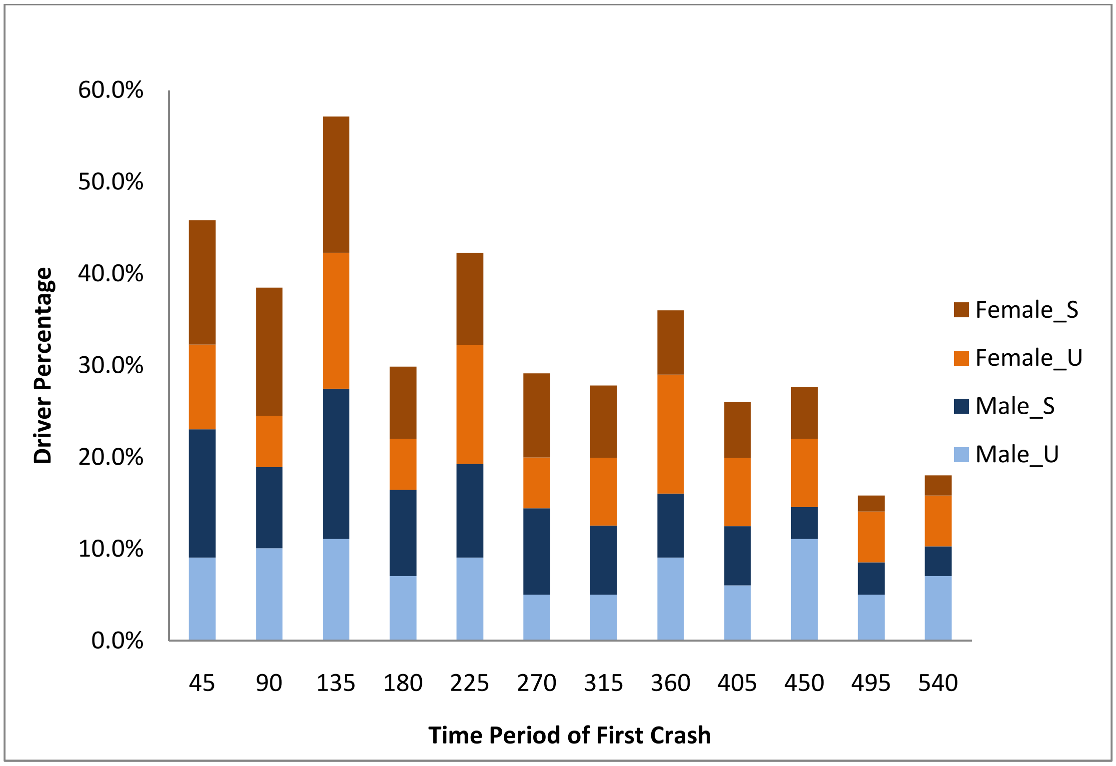

Figure 4.20 Days of first crash by gender and outcome over 18 months after DIP

Figures 4.21and 4.22 show the number of days until drivers' first conviction or crash by age and outcome over 18 months after DIP, and corresponding percentages. Figure 4.21 shows that drivers in the S group had lower conviction occurrence than drivers in the U group. A higher percentage of young drivers (30 years of age or younger) had their first conviction in the first 135 days than the other two age groups, but the differences became smaller after that. Figure 4.22 shows that first 135 day-period and last 45 days of the probation period were the two most frequent time periods, in which most drivers were involved in their first crash. Interestingly, a higher percentage of drivers in the S group were involved in a crash than drivers in the U group.

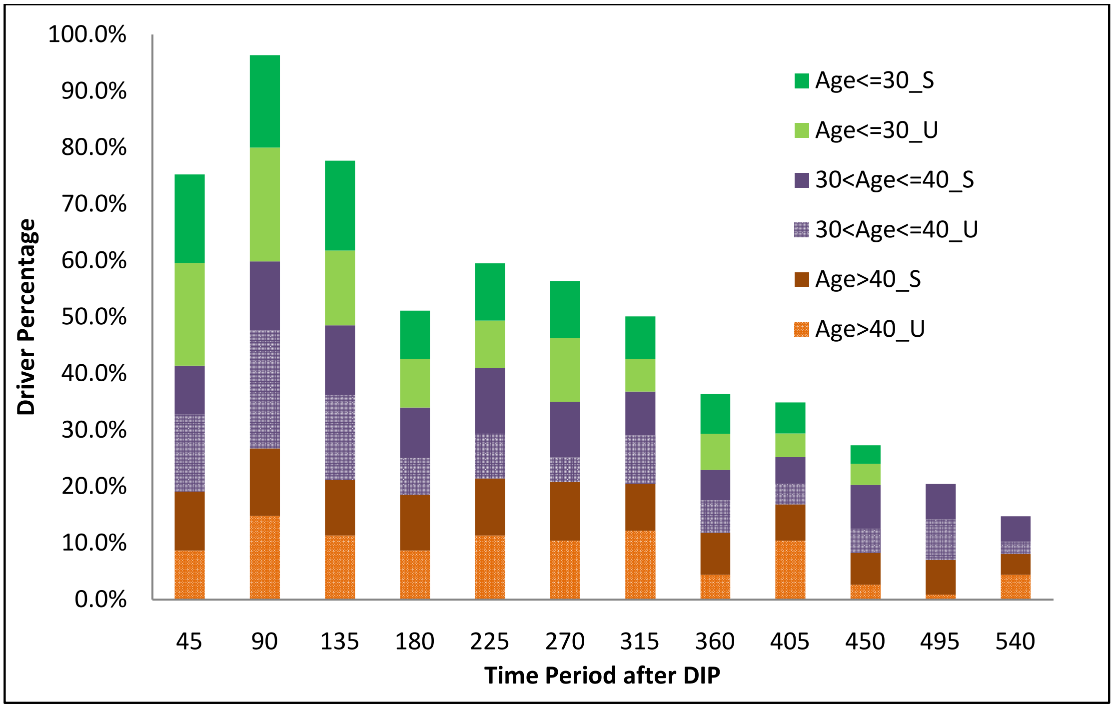

Figure 4.21 Days of first conviction by age and outcome over 18 months after DIP

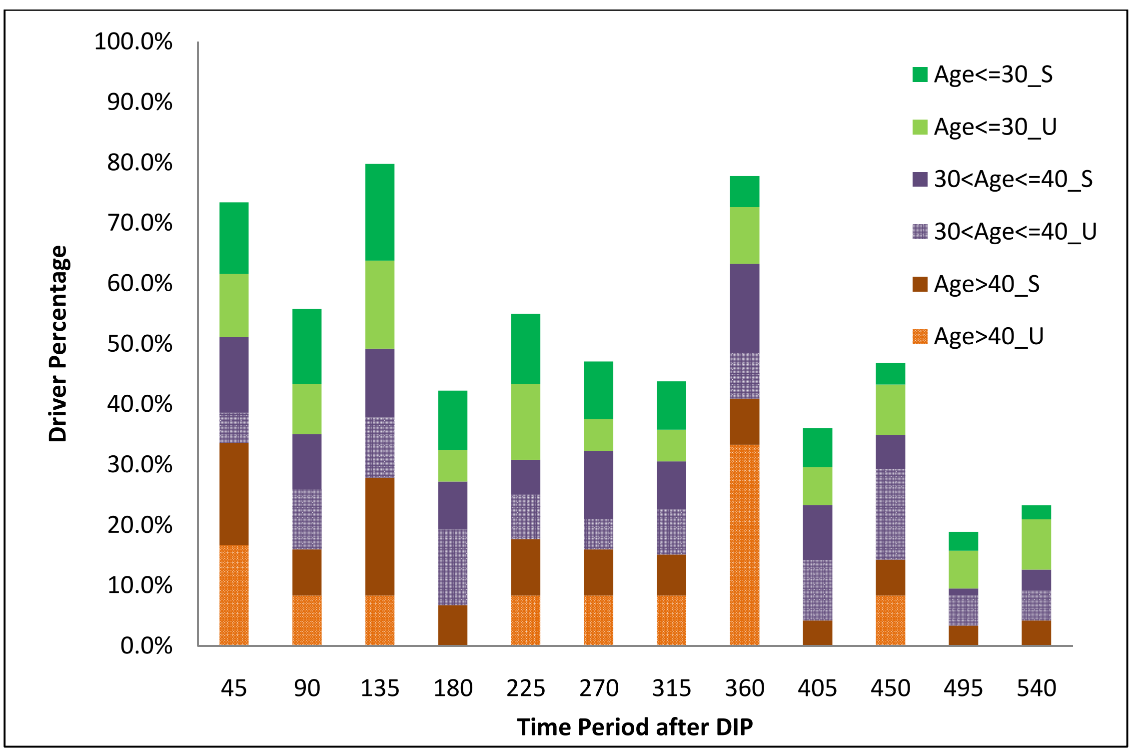

Figure 4.22 Days of first crash by age and outcome over 18 months after DIP

In summary, there was a decreasing trend in conviction occurrence over time, while crashes did not follow any particular trend. A higher percentage of male drivers and drivers 40 years old or younger had their first action within the first 135 days after DIP. It is recommended that low-cost, early intervention measures such as advisory letters are sent to these groups shortly after the completion of DIP.

4.3.7 Driver Convictions, Location and DIP Outcome

Herein, any spatial differences in the program's effectiveness across Iowa where the driver improvement program is offered are examined. Figure 4.22 shows the percentage of drivers who completed DIP at each community college and did not have any action during the probation period. The percentages are in the range of 60–81%. Community colleges in Marshalltown, Council Bluffs, and Sheldon had the highest percentage of drivers who did not have any action during the first year after attending DIP.

Figure 4.23 shows the percentage change in the number of subsequent convictions during the probation period, and during the 13^{th} to 18^{th} month period after DIP date, per driver who completed DIP at each community college and had actions during the probation period (S_1). The percentage changes range from 64% to 78 % during the probation period and from 94% to 100% during the 13^{th} to 18^{th} month period after DIP date. Drivers who attended DIP in Emmetsburg (78%), Marshalltown (77%), Denison/ Sioux City (77%) had the highest percentage decrease in subsequent convictions during the probation period; while drivers who completed the course in Fort Dodge (100%), Ottumwa (99%), Waterloo (99%), and Creston (99%) had the highest decrease in subsequent convictions the 13th to 18th month period subsequent to DIP.

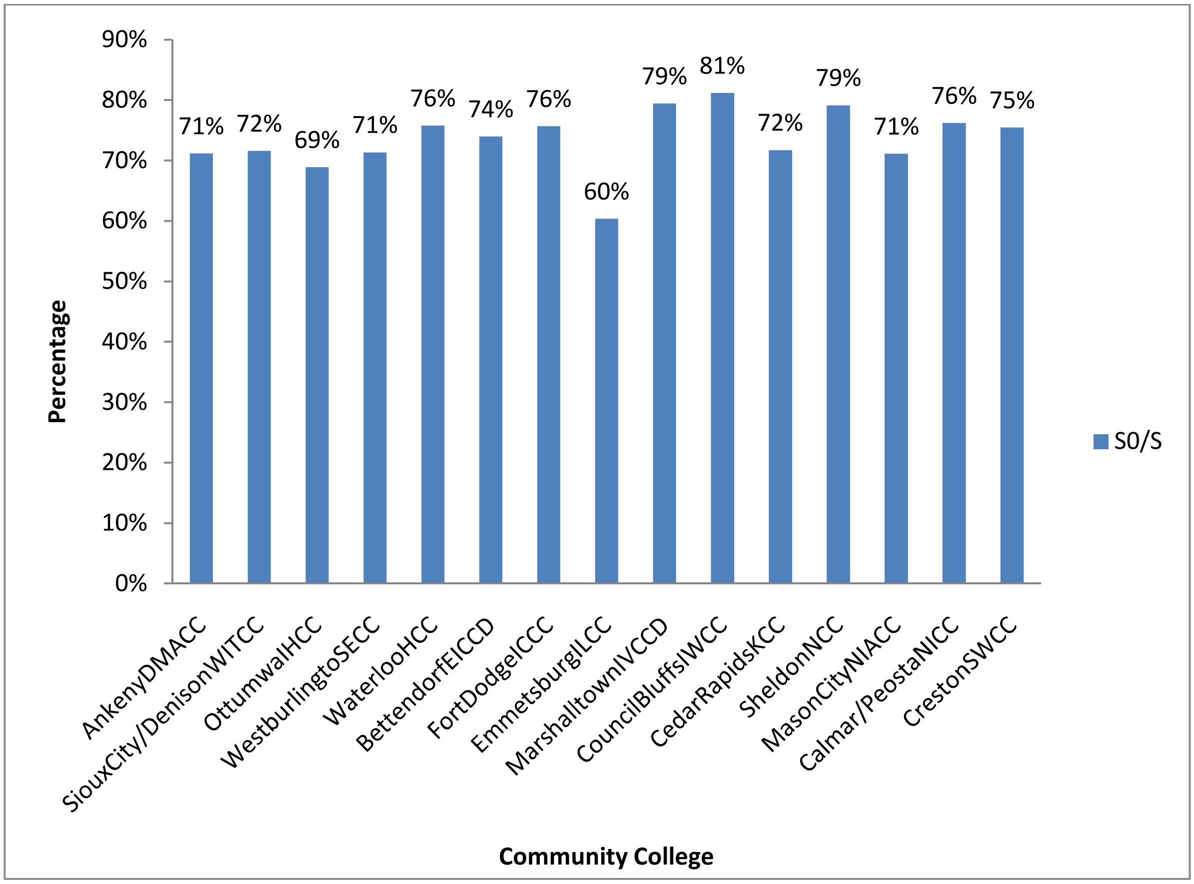

Figure 4.22 Percentage of drivers who completed DIP at each community college and did not have any action during the probation period

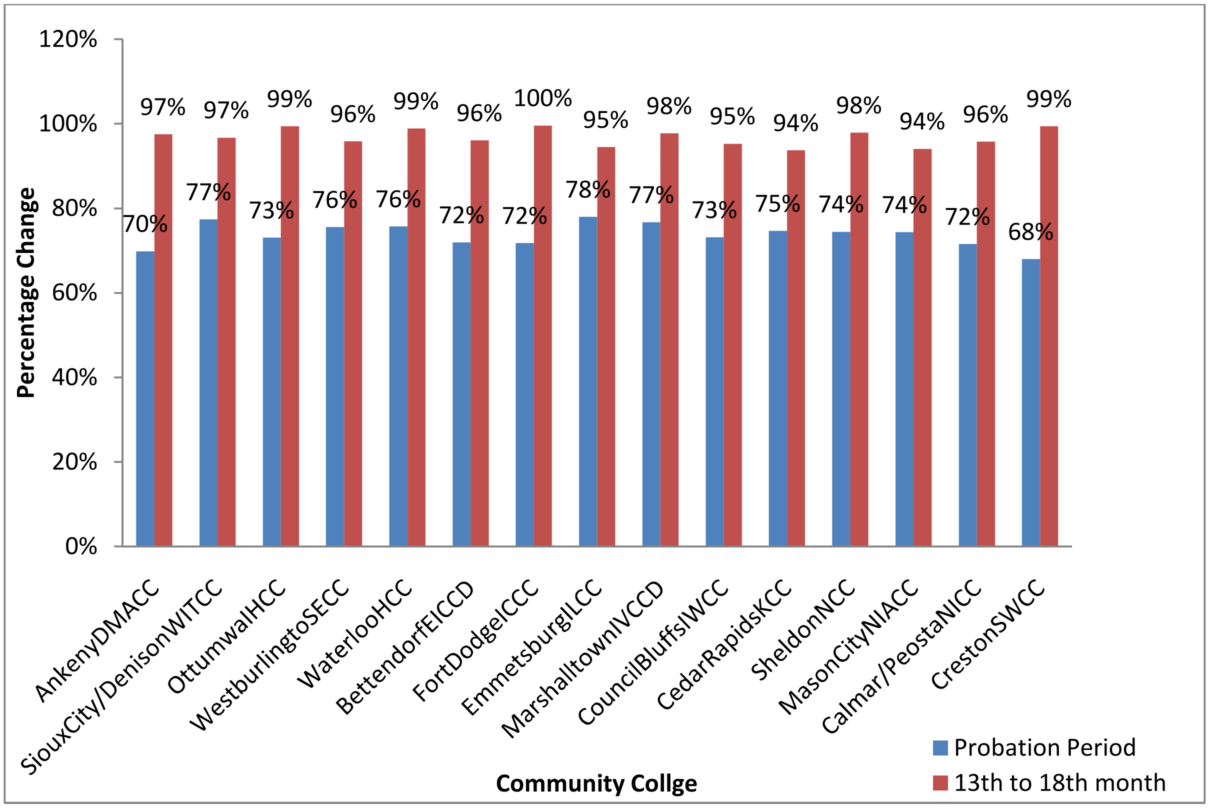

Figure 4.23 Percentage change in subsequent convictions per driver

4.4 Summary

In this Chapter, the data on driver citations, convictions, and crashes, and driver education training history were summarized and interpreted using descriptive analysis techniques and graphical representations. Preliminary findings showed that 73% of DIP participants did not have any conviction and 93% of DIP participants were not involved in a crash during the probation period (12 months after DIP date). It is also found that male drivers and young drivers (30 years of age or younger) incurred more convictions, while older drivers (40 years of age or older) had fewer crashes in both the satisfactory and unsatisfactory groups. Drivers in the satisfactory groups had lower conviction rates than drivers in the unsatisfactory group. While these findings suggest a reduction in conviction for the driver population who attended DIP and show differences of convictions and crashes in gender and age by DIP outcome, there is a need for further analysis to statistically verify these preliminary findings. The results of the statistical analysis are presented in Chapter 5.

CHAPTER 5. STATISTICAL DATA ANALYSIS

5.1 Overview

In this chapter, statistical methods are used to examine the effectiveness of Iowa's Driver Improvement Program (DIP) by age and gender, measured as the reduction in the number of violations within 12 months subsequent to the driver improvement program. First, probabilistic models are developed to estimate the likelihood of conviction occurrence subsequent to DIP. The factors that are used to examine differences in DIP's effectiveness by gender and age include: gender, age, outcome, location and interaction effects among these factors. Evaluating the effect of location on the occurrence of subsequent convictions can provide insights on whether there are any spatial differences in the program's effectiveness across Iowa where the DIPs are offered, and whether certain specific groups need to be closely monitored at each DIP location. Then, count data models are applied to investigate the factors that influence the frequency of subsequent convictions by gender and by age, as a function of driver characteristics and conviction/crash history.

5.2 Estimation Results

5.2.1 Conviction Occurrence after DIP

Binary probit models were used to estimate conviction occurrence after DIP by gender and age respectively. The estimation results are presented in the next sections.

5.2.1.1 Conviction occurrence after DIP by Gender

The likelihood ratio test (Washington et al. 2003, p. 282) was estimated to determine whether it was statistically significant to estimate separate models by age and gender or a single model calibrated on the whole dataset was preferred. Table 5.1 shows the estimation results of the likelihood ratio test. The likelihood ratio test was estimated using the same variables in all three models (all data (T), conviction data during the probation period for male drivers (a) and conviction data during the probation period for female drivers (b)), using $X^2 = -2(LL(\beta_T) - LL(\beta_a) - LL(\beta_b))$. The resulting X^2 statistic showed that it was statistically significant to estimate two separate models.

Table 5.1 Likelihood ratio test estimation for conviction occurrence after DIP by gender

	Total $LL(\boldsymbol{\beta}_T)$	Male $LL(\boldsymbol{\beta}_a)$	Female $LL(\boldsymbol{\beta}_b)$	X^2	Number of Parameters	Critical Value
Log-likelihood at Convergence $LL(\boldsymbol{\beta})$	-4816.9	-3127.3	-1669.9	39.4		9.4877
Number of Parameters	12	9	7		4	

Table 5.2 shows the binary probit model estimation results for conviction occurrence within 12 months after DIP by gender and Table 5.3 presents the estimated elasticity values of this binary probit model. The model outputs are provided in Appendix E.1.

Table 5.2 Binary probit model estimation results for conviction occurrence after DIP by gender

	Male		Female	
Variable	**Estimated Coefficient**	**t-Statistic**	**Estimated Coefficient**	**t-Statistic**
Constant	-0.576	-12.35	-0.428	-6.33
DIP outcome: satisfactory	-0.140	-3.39	-0.145	-2.59
Driver with one conviction before DIP	-0.385	-5.76	-0.428	-4.77
Driver with three convictions before DIP	-0.160	-4.00	-0.247	-4.07
Driver with four convictions before DIP			-0.179	-2.680
Driver with no crash before DIP			-0.209	-3.37
Driver over 50 years old	-0.275	-4.02		
Driver between 21 and 30 years old with no crash before DIP	0.090	2.21	0.172	2.79
Driver between 41and 50 years old with no crash before DIP	-0.149	-2.35		
Community college: DMACC	0.124	3.08		
Community college: KCC	0.113	2.12		
Number of Observations	5,810		3,245	
Log-likelihood at convergence	-3,127.3		-1,669.9	
Log- likelihood at zero	-3,180.4		-1,697.2	

Table 5.3 Estimated elasticity values of the binary probit model for conviction occurrence after DIP by gender

	Elasticity	
Variable	Male	Female
DIP outcome: satisfactory	-13.1	-9.4
Driver with one conviction before DIP	-23.8	-26.5
Driver with three convictions before DIP	-14.8	-15.8
Driver with four convictions before DIP		-11.7
Driver with no crash before DIP		-13.2
Driver over 50 years old	-17.4	
Driver between 21and 30 years old with no crash before DIP	6.2	12.4
Driver between 41and 50 years old with no crash before DIP	-9.7	
Community college: DMACC	8.6	
Community college: KCC	7.8	

Negative coefficient values showed that both male and female drivers who completed DIP and drivers with one or three convictions before DIP were less likely to have subsequent conviction(s) during the probation period than the other drivers. In addition, both male and female drivers between 21and 30 years old with no crash before DIP had higher probability to have subsequent convictions (elasticity of 6.2% and 12.4%, respectively). Elasticity estimation showed that male drivers who completed classes had a 13.1% lower probability to be involved in convictions subsequent to DIP than male drivers who did not complete or didn’t attend, while female drivers had a 9.4% lower probability incurring convictions than its counterparts. This means that the DIP outcome variable influences at a higher degree the conviction probability for male drivers than female drivers. In other words, DIP seems to have a greater effectiveness overall in reducing subsequent convictions for male than female drivers. However, when conviction history is accounted for, similar effects for both male and female drivers were found with respect to the reduction in subsequent convictions. .

While same factors were found in both models to influence the subsequent conviction probability, there were also differences as described next. In the male-specific model, drivers over 50 years old, and drivers between 41and 50 years old with no crash before DIP had a lower risk for conviction, while drivers who were instructed to attend DIP at DMACC in Ankeny or at KCC in Cedar Rapids were more likely to have subsequent conviction(s). Female drivers with four convictions before DIP and drivers with no crash before DIP were less likely to have a conviction during the probation period after DIP (elasticity of -11.7% and -13.2%, respectively).

This analysis showed that younger drivers (between 21 and 30 years old) could benefit from early intervention measures during the probation period, such as advisory or warning letters. Furthermore, there seem to be spatial differences in DIP effectiveness. It is speculated that these findings are picking up differences in driver behavior in the presence of enforcement (or lack thereof) and DIP instruction across different geographical areas in Iowa. While the differences in the level of enforcement or DIP instruction could not be explicitly examined across the community colleges that offer DIP, differences were examined in the attributes of the driver population who attended DIP at the three colleges with the highest DIP participation rates (DMACC, EICCD, and KCC). Table 5.4 shows the distribution of drivers at each college by gender and age group.

Table 5.4. Distribution of drivers in the three community colleges by gender and age

		Community College			
		DMACC*	**EICCD***	**KCC***	**Grand Total**
Female drivers	20 years old or younger	73 (2%)	44 (4%)	18 (1%)	135
	21–30 years old	580 (19%)	232 (19%)	299 (22%)	1,111
	31–40 years old	217 (7%)	94 (8%)	96 (7%)	407
	41–50 years old	152 (5%)	47 (4%)	69 (5%)	268
	51 years old or older	93 (3%)	30 (2%)	44 (2%)	167
Total		1,115 (36%)	447 (37%)	526 (38%)	2,088
Male drivers	20 years old or younger	137 (4%)	64 (5%)	39 (3%)	240
	21–30 years old	975 (31%)	368 (30%)	452 (33%)	1,795
	31–40 years old	401 (13%)	163 (13%)	192 (14%)	756
	41–50 years old	303 (10%)	92 (8%)	105 (8%)	500
	51 years old or older	190 (6%)	74 (6%)	75 (5%)	339
Total		2,006 (64%)	761 (63%)	863 (62%)	3,630
Grand Total		3,121(34%)	1208(13%)	1389(15%)	5,718

*DMACC: Des Moines Area Community College in Ankney
*EICCD: Eastern Iowa Community College District in Benttendorf
*KCC: Kirkwood Community College in Cedar Rapids

It can be inferred that drivers who were instructed to attend DIP in DMACC have similar characteristics to the average driver in the final sample (see Table 4.3). Female drivers were slightly overrepresented at EICCD and KCC (37% and 38%, respectively) compared to 36% of female drivers in the total sample. Turning to the distribution of drivers by age group, the following can be observed: younger drivers (20 years old or younger) were overrepresented at EICCD and underrepresented at KCC; drivers between 21 and 40 years old were overrepresented at KCC, while older drivers (older than 50 years old) were underrepresented; and drivers between 31 and 40 years old were overrepresented at EICCD, while older drivers (older than 41 years old) were underrepresented.

5.2.1.2 Conviction occurrence after DIP by Age

Table 5.5 shows the estimation results of the likelihood ratio test. The likelihood ratio test was estimated using the same variables in all four models (all data (T), conviction data during the probation period for drivers 30 years of age or younger than (a), conviction data during the probation period for drivers in between 31 and 40 years of age (b), and conviction data during the probation period for drivers older than 40 years of age (c)), using$X^2 = -2(LL(\beta_T) - LL(\beta_a) - LL(\beta_b) - LL(\beta_c))$. The resulting X^2 statistic showed that it was statistically significant to estimate three separate models

Table 5.5 Likelihood ratio test estimation for conviction occurrence after DIP by age group

	Total $LL(\beta_T)$	Age≤30 $LL(\beta_a)$	Age 31-40 $LL(\beta_b)$	Age>40 $LL(\beta_c)$	X^2	Number of Parameter	Critical Value
Log-likelihood at Convergence $LL(\beta)$	-4816.9	-2927.4	-885.8	-982.1	43.3		9.4877
Number of Parameters	12	6	5	5		4	

Table 5.6 shows the binary probit model estimation results for conviction occurrence within 12 months after DIP for three age groups and Table 5.7 presents the elasticity estimation results of this model. The model outputs are provided in Appendix E.1.

Table 5.6 Binary probit model estimation results for conviction occurrence after DIP by age group

	Age≤30		Age 31-40		Age >40	
Variable	**Estimated Coefficient**	**t-Statistic**	**Estimated Coefficient**	**t-Statistic**	**Estimated Coefficient**	**t-Statistic**
Constant	-.0496	-11.65	-0.592	-8.52	-0.640	-8.510
DIP outcome: satisfactory	-0.100	-2.25	-0.232	-2.85	-0.273	-3.260
Driver with one conviction before DIP	-.0405	-5.82	-0.447	-3.52	-0.425	-3.838
Driver with three convictions before DIP	-0.180	-4.05	-0.243	-3.25	-0.194	-2.734
Driver who completed DIP with four convictions before DIP	-0.149	-2.59				
Male driver with no crash before DIP	0.078	2.03				
Driver who completed DIP at DMACC			0.207	2.49	0.254	3.400
Number of Observations		5199		1775		2081
Log-likelihood at convergence		-2927.4		-885.8		-982.1
Log- likelihood at zero		-2955.3		-900.6		-999.6

Table 5.7 Estimated elasticity values of the binary probit model for conviction occurrence after DIP by age group

	Elasticity		
Variable	**Age≤30**	**Age 31-40**	**Age >40**
DIP outcome: satisfactory	-6.3	-14.7	-17.2
Driver with one conviction before DIP	-24.6	-27.9	-27.5
Driver with three convictions before DIP	-11.3	-15.7	-13.0
Driver who completed DIP with four convictions before DIP	-9.5		
Male driver with no crash before DIP	5.3		
Driver who completed DIP at DMACC		15.3	19.4

Fewer significant variables were identified to significantly affect conviction occurrence by age compared to those identified by gender (and presented in the previous section). Factors such as DIP outcome and low conviction history before DIP were common across the “gender” and “age” models. Furthermore, the elasticity estimation showed that the DIP outcome variable influences at a higher degree the conviction probability of drivers between 31 and 40 years of age and drivers 41 years of age or older than young drivers (30 years of age or younger). This suggests DIP completion is more effective for older drivers than younger drivers in decreasing the probability of subsequent convictions after DIP. This was also concluded in the analysis by gender. The elasticity values of the conviction occurrence for drivers with low conviction history were the highest in the model, though did not vary considerably by age. In addition, it was found that drivers with low conviction history (up to three convictions) before DIP were at lower risk for subsequent convictions, compared to drivers with three convictions before DIP.

While same factors in the three models were found to influence the subsequent conviction probability, there were also differences as described next. Young drivers (30 years old or younger) who completed DIP and had four convictions before DIP were 9.5% less likely to incur a conviction. This shows evidence of the effectiveness of DIP on young and high-risk drivers. In contrast, young male drivers with no crash before DIP, and older drivers (31 years old or older) who completed DIP at DMACC were at higher risk for subsequent convictions. Moreover, there are fewer significant variables in the models of conviction occurrence by age than those in the models of conviction occurrence by gender. In general, younger male drivers and older drivers who completed DIP at DMACC should be closely monitored during the probation period after DIP.

5.2.2 Frequency of Convictions Subsequent to DIP

Count data models were used to estimate the frequency of conviction subsequent to DIP by gender and age, respectively. The estimation results are presented in the next sections.

5.2.2.1 Frequency of convictions subsequent to DIP by gender

Table 5.8 shows the estimation results of the likelihood ratio test. The likelihood ratio test was estimated using the same variables in all three models (all data (T), conviction data during the probation period for male drivers (a) and conviction data during the probation period for female drivers (b)), using $X^2 = -2(LL(\beta_T) - LL(\beta_a) - LL(\beta_b))$. The resulting X^2 statistic showed that it was statistically significant to estimate two separate models.

Table 5.8 Likelihood ratio test estimation for frequency of convictions by gender

	Total $LL(\beta_T)$	Male $LL(\beta_a)$	Female $LL(\beta_b)$	X^2	Number of Parameters	Critical Value
Log-likelihood at Convergence $LL(\beta)$	-6403.3	-4184.2	-2214.2	9.832		3.8415
Number of Parameters	16	11	6		1	

Table 5.9 shows the negative binomial model estimation results for frequency of convictions within 12 months after DIP by gender, and Table 5.10 presents the elasticity of this negative binomial model. The model outputs are provided in Appendix E.2.

Table 5.9 Negative binomial regression model for frequency of convictions by gender

	Male		Female	
Variable	**Estimated Coefficient**	**t-Statistic**	**Estimated Coefficient**	**t-Statistic**
Constant	-0.554	-7.96	-0.848	-12.04
DIP outcome: satisfactory	-0.384	-5.72	-0.279	-3.24
Driver with one conviction before DIP	-0.613	-5.94	-0.665	-4.58
Driver with three convictions before DIP	-0.296	-4.67	-0.267	-3.13
Driver between 31and 40 years old	-0.386	-4.76		
Driver between 41and 50 years old	-0.418	-4.61		
Driver over 50 yrs old	-0.734	-6.23		
Driver between 21and 30 years old with four convictions before DIP	-0.237	-2.62		
Driver between 21and 30 years old , sent to DMACC	-0.185	-1.97		
Driver who completed DIP at DMACC	0.318	3.81		
Driver between 31and 40 years old completed DIP			-0.260	-2.16
Number of Observations		5,810		3,245
Log-likelihood at convergence		-4184.2		-2214.2
Log- likelihood at zero		-4298.4		-2292.6

Table 5.10 Estimated elasticity values of negative binomial regression model for frequency of convictions by gender

	Elasticity	
Variable	**Male**	**Female**
DIP outcome: satisfactory	-46.8	-32.2
Driver with one conviction before DIP	-84.6	-94.5
Driver with three convictions before DIP	-34.5	-30.6
Driver between 31and 40 years old	-47.1	
Driver between 41and 50 years old	-51.9	
Driver over 50 yrs old	-108.3	
Driver between 21 and 30 years old with four convictions before DIP	-26.7	
Driver between 21 and 30 years old sent to DMACC	-20.3	
Driver who completed DIP at DMACC	27.2	
Driver between 31and 40 yrs old completed DIP		-29.7

It was found that there are common factors that affect the probability of a driver incurring a conviction subsequent to DIP and the number of subsequent convictions during the probation period. The most notable are DIP outcome (satisfactory completion,) and low conviction history leading to less subsequent convictions.

Older drivers, male drivers between 21and 30 years of age with four convictions before DIP or sent to DMACC, female drivers who completed DIP between 31and 40 years of age are more likely to have fewer convictions. However, male drivers who completed DIP at DMACC incurred more convictions (note that these group of drivers were also in higher risk for conviction occurrence). Elasticity estimation showed that male drivers over 50 years (elasticity of -108.3%) and female drivers with one conviction before DIP (elasticity of 94.5%) were less likely to incur subsequent convictions than their counterparts. These two estimates represent elastic (or close to elastic) effects.

5.2.2.2 Frequency of convictions subsequent to DIP by age

Table 5.2 shows the estimation results of the likelihood ratio test. The likelihood ratio test was estimated using the same variables in all four models (all data (T), conviction data during the probation period for drivers 30 years of age or younger(a), conviction data during the probation period for drivers in between 31 and 40 years of age (b), and conviction data during the probation period for drivers older than 40 years of age (c)), using $X^2 = -2\left(LL(\beta_T) - LL(\beta_a) - LL(\beta_b) - (\boldsymbol{LL}(\boldsymbol{\beta_c}))\right)$ The resulting X^2 statistic showed that it was statistically significant to estimate three separate models.

Table 5.11 Likelihood ratio test estimation of for frequency of convictions by age group

	Total $LL(\boldsymbol{\beta_T})$	**Age≤30 $LL(\boldsymbol{\beta_a})$**	**Age 30-40 ($LL(\boldsymbol{\beta_b})$**	**Age>40 $LL(\boldsymbol{\beta_c})$**	**X^2**	**Number of Parameters**	**Critical Value**
Log-likelihood at Convergence $LL(\boldsymbol{\beta})$	-6403.3	-4008.7	-1162.9	-1218.6	26.4		7.8147
Number of Parameters	16	11	6	6		3	

Table 5.12 shows the negative binomial model estimation results for frequency of convictions within 12 months after DIP by three age groups, and Table 5.13 presents the elasticity of this negative binomial model. The model outputs are provided in Appendix E.2.

Table 5.12 Negative binomial regression model for frequency of convictions by age group

	Age≤30		Age 30-40		Age >40	
Variable	**Estimated Coefficient**	**t-Statistic**	**Estimated Coefficient**	**t-Statistic**	**Estimated Coefficient**	**t-Statistic**
Constant	-0.913	-19.73	-0.842	-9.28	-1.11	-10.30
DIP outcome: satisfactory			-0.525	-4.18	-0.526	-4.16
Male driver who didn't complete DIP	0.228	3.20				
Driver with one conviction before DIP	-0.592	-5.69	-0.691	-3.38	-0.732	-3.62
Driver with three convictions before DIP	-0.268	-4.11	-0.361	-2.98	-0.289	-2.60
Driver who completed DIP with four convictions before DIP	-0.226	-2.77				
Driver with one crash before DIP					0.365	3.14
Driver who completed DIP at DMACC			0.333	2.33	0.457	3.81
Number of Observations		5199		1775		2081
Log-likelihood at convergence		-4008.7		-1162.9		-1218.6
Log- likelihood at zero		-4126.6		-1208.9		-1245.0

Table 5.13 Estimated elasticity values of negative binomial regression model for frequency of convictions by age group

	Elasticity		
Variable	**Age≤30**	**Age 30-40**	**Age >40**
DIP outcome: satisfactory		-69.1	-69.2
Male driver who didn't complete DIP	20.4		
Driver with one conviction before DIP	-80.8	-99.6	-107.9
Driver with three convictions before DIP	-30.7	-43.5	-33.5
Driver who completed DIP with four convictions before DIP	-25.4		
Driver with one crash before DIP			30.6
Driver who completed DIP at DMACC		28.3	36.7

Compared with conviction occurrence model, more common factors determining the frequency of subsequent convictions were found significant across the three age groups. Drivers with lower conviction history were more likely to have fewer subsequent convictions irrespective of age. However, the elasticity estimation showed that the effect is higher and elastic for older drivers. Drivers over 30 years of age who completed DIP were 69% less likely to incur convictions than other drivers, while drivers over 30 years of age who completed DIP at DMACC were more likely to incur a conviction. Driver groups with higher number of convictions by age include male drivers under 30 years of age, who did not complete DIP, and drivers over 40 years of age with one crash before DIP.

5.2.3 Crash occurrence after DIP

As indicated in Chapter 4, 7% of drivers of DIP participants were involved in a crash within 12 months after the DIP date, and only 2% of DIP participants were involved in a crash during the period from 13 to 18 months after DIP. Due to the low variation in the subsequent number of crashes, model couldn't be estimated. As such, association rules are applied and lift values are calculated to estimate the likelihood of the occurrence of one crash after DIP by gender and age.

Before explaining the association results, minimum thresholds for support and confidence were specified first. The threshold values used in the analysis are 1.0% and 6%, respectively. It means that no rules with support <1.0% and/or confidence <6% would be considered irrespective of their lift values. Due to the rare crash characteristic, these thresholds are lower than the values typically used in market basket analysis. A past study on the identification of accident circumstances that frequently occurred simultaneously (Geurts et al. (2005)) used 5% as the threshold on support parameter, which is close to the values typically used in market basket analysis. However, due to the low crash occurrence and frequency within 12 months subsequent to DIP in our sample, the support for the rules of interest had to be set much lower. As such, the importance of the rules is also evaluated based on the Lift values.

Table 5.14 shows the association rules between the cause factors and the consequence "one crash occurrence within 12 months after DIP" for the total sample of drivers, and also by gender and age. Only the lift values with support higher than 1% and confidence higher than 6% are shown in Table 5.14. The table includes the following values:

- Cause factor
- Lift value, which represents the association between cause factors and one crash occurrence after DIP.
- Confident value (%), which represents the probability that one crash occurred under the condition that cause factors occurred

- Support value (%), which represents the probability cause factors and one crash occurrence happened together.

Table 5.14 Lift Values for "One Crash Occurrence within 12 months after DIP"

Cause Factor	Lift	Confidence	Support
Three convictions before DIP	0.96	6%	2.0%
Four convictions or more before DIP	1.04	6%	2.9%
Satisfactory	1.05	6%	4.8%
30 years of age or younger	1.08	7%	3.8%
One crash before DIP	1.09	7%	1.6%
Male drivers with five convictions before DIP	1.37	8%	1.0%
Drivers between 31 and 40 years of age with one crash before DIP	1.51	8%	1.6%
Drivers between 31 and 40 years of age with five convictions before DIP	1.82	10%	1.2%

Interestingly, drivers with high conviction history (three convictions or more before DIP) were not more likely to be involved in a crash after DIP than other drivers (Lift values very close to one). Likewise, drivers who completed DIP successfully were not less likely to be involved a crash after DIP than other drivers (Lift value very close to one). Lastly, younger drivers (30 years of age or younger) and drivers with one crash before DIP were marginally more likely to be involved in a crash than other drivers.

When studying the differences in crash occurrence by gender and age, it is interesting to find that male drivers with five convictions before DIP, and drivers between 31 and 40 years of age with one crash or five convictions before DIP were 1.37, 1.82 and 1.5 times respectively more likely to be involved in a crash after DIP than the rest of the drivers. However, note that the support for these rules is quite low.

5.3 Summary

In this chapter, the results of the statistical analysis were presented. Estimation results showed that that there are common factors between male and female drivers and across age groups that determine the likelihood and frequency of subsequent convictions. Furthermore, DIP was found to be effective in reducing the likelihood and frequency of subsequent convictions, but was not significant in reducing the likelihood of crash occurrence after DIP. Driver history and DIP location, and interaction effects among these factors were also found to be significant determinants of the likelihood and frequency of subsequent conviction.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

This study examined the effectiveness of Iowa's DIP by gender and age by determining the reduction in the number of driver convictions after drivers attended the DIP. The analysis involved a random sample of 9,055 drivers who had been directed to attend DIP. The sample was divided into two groups based on gender (female and male), and three groups based on age (30 years of age or younger, 31 to 40 years of age, and older than 40 years of age). In each specific group, the sample was then divided into two groups based on the DIP outcome, satisfactory or unsatisfactory completion. The "satisfactory" group (S) consisted of drivers who successfully completed the DIP course. The "unsatisfactory" group (U) consisted of drivers who did not complete or did not attend the DIP course after they received a letter to attend DIP. Interestingly, the distribution of men and women in each group was the same (64% and 36%, respectively), which suggests that there was no difference between male and female drivers with respect to the DIP outcome. However, the percentages of three age group drivers are not the same in S and U group, which suggests there might be differences among the three age groups of drivers with respect to the DIP outcome (satisfactory or unsatisfactory).

Actions were tracked four years prior to the DIP date. The DIP date refers to the date when drivers were instructed to attend DIP. Action types were categorized into Iowa DOT actions or sanctions (suspension, disqualified, and revoked license) and driver actions (convictions and crashes). It should be noted that the license of the drivers in the "unsatisfactory" group would be suspended, while the license of the drivers in the "satisfactory" group would be suspended after DIP upon their first conviction within the probation period. The probation period (one year after the date drivers were sent to DIP) were used to examine the effectiveness of the program on reducing subsequent driver actions.

The evaluation of Iowa's DIP showed that there is evidence of effectiveness in terms of reducing the number of convictions subsequent to DIP. Among the total 9,055 drivers in the sample, 6,790 (75%) drivers completed the course satisfactorily, while 2,265 (25%) drivers were included in the "unsatisfactory" group. Among the 6,790 drivers in the "satisfactory" group, 73% of drivers had no actions and 93% were not involved in a crash during the probation period. This finding shows a decrease in subsequent actions for the majority of DIP participants. Specifically, only 7% of DIP participants were involved in a crash during the probation period after attending DIP, and only 2% of DIP participants were involved in a crash during the period 13 to 18 months after attending DIP. Turning to the differences by age and gender, male drivers and young drivers (30 years of age or younger) incurred more convictions, while older drivers (40 years of age or older) had fewer crashes in both the satisfactory and unsatisfactory groups. Drivers in the satisfactory groups had lower conviction rates but more crashes than unsatisfactory group.

Turning to the type of violation, similar violation types led the drivers in both groups (unsatisfactory [U] and satisfactory [S]) to attend DIP, with speeding being the most common reason. After speeding, speeding less than 10 mph over the posted speed limit in 35-55 mph zones, no driver's license and driving while suspended were frequent reasons for receiving a citation after attending DIP. It is recommended that DIP instruction focus on these types of citations. In addition, careless driving and obeying traffic sign/signal should be emphasized in DIP instruction materials towards men, young drivers (30 years of age or younger) and older drivers (40 years of age or older).

Turning to the days until the first conviction and crash occurrence, most drivers had their first conviction within 90 days after DIP. A higher percentage of male drivers and drivers 30 years old or younger had their first action within the first 135 days after DIP. While there is a decreasing trend in conviction occurrence over time, crashes did not follow any particular trend. It is recommended that low-cost, early intervention measures such as advisory letters are sent to these groups shortly after the completion of DIP.

Statistical models were developed to examine the effect of factors such as age, gender DIP outcome, DIP location, and interaction effects among these factors on occurrence and frequency of subsequent convictions by gender and age. It was found that drivers who did not attend or complete DIP satisfactorily were more likely to incur convictions during the probation period than drivers who completed DIP satisfactorily which shows the positive effect of satisfactory DIP completion. Moreover, drivers with low conviction history were at a lower risk for conviction, while both male and female young drivers (between 21 and 30 years of age) with no crash before DIP had a higher risk for conviction.

Different effects of factors on the occurrence and frequency of subsequent convictions were identified by gender and by age. Older male drivers (drivers over 50 years old) and female drivers with four convictions or no crash before DIP were less likely to have a conviction during the probation period. Young drivers (30 years of age or younger) who completed DIP and had four convictions before DIP also were less likely to incur a conviction. This shows evidence of the effectiveness of DIP on young and high-risk drivers. In contrast, male drivers who were instructed to attend DIP at DMACC in Ankeny or at KCC in Cedar Rapids, young male drivers with no crash before DIP, and older drivers (31 years of age or older) who completed DIP at DMACC were at higher risk for subsequent convictions. In general, younger male drivers and older drivers who completed DIP at DMACC should be closely monitored during the probation period after DIP. The findings on the effect of location are likely picking up differences in driver behavior in the presence of enforcement (or lack thereof) and DIP instruction across different geographical areas in Iowa. A closer examination of DIP instruction across the 17 community colleges could help explain these spatial differences in DIP effectiveness.

Due to the low variation in the subsequent number of crashes, association rules were applied and lift values were calculated to estimate the likelihood of the occurrence of one crash after DIP by gender and age. It was found drivers with high conviction history (three convictions or more before DIP) were not more likely to be involved in a crash after DIP than other drivers. Turning to the high-risk drivers groups: younger drivers (30 years of age or younger and drivers with one crash before DIP were marginally more likely to be involved in a crash than other drivers. Turning to the DIP outcome, drivers who completed DIP successfully were not less likely to be involved a crash after DIP than other drivers. When studying the differences in crash occurrence by gender and age, it is interesting to find that male drivers with five convictions before DIP, and drivers between 31 and 40 years of age with one crash or five convictions before DIP were more likely to be involved in a crash after DIP than the rest of the drivers.

Additional recommendations related to the adoption of other driver education training mechanisms and materials for reducing the traffic conviction rate of high-risk drivers, in particular, are summarized as follows:

Iowa offers certain driving improvement programs, such as driver improvement school and the policy of suspending the driving privileges of habitual violators, serious violations, and countable moving violations. Iowa also implements the GDL program for drivers under 17 years old. In view of the findings of the literature review, the Motor Vehicle Division can also consider adopting other driver education training mechanisms and materials, such as home-study courses (online courses), which are low-cost but not less effective than the in-person study, and implementing a mature driver improvement program, which is essential to retrain older drivers in new skills and knowledge.

Advisory or warning letters should also be considered as a low-cost, early intervention measure to advise/warn drivers before they become high-risk drivers and/or are involved in a crash. Previous work has established the effectiveness of driver improvement letters, advisory letters, and warning letters in reducing safety risk and has found that the effectiveness of each type of letter varied by age group. For example, standard letters, which emphasize the threat of subsequent crashes or violations, are more effective for younger male and female drivers, while soft-sell letters, in which more emphasis is put on positive motivations, encouragement and benefits, are more effective for drivers older than 45. As such, it is recommended that the content of the letters be customized based on the driver's age. Specifically, in view of this study's findings, standard letters could be addressed to young drivers between 21 and 30 years old, especially male drivers. Soft letters could be mainly addressed to drivers older than 40 years old with one crash before DIP.

In addition, in view of the analysis results, it is important that high-risk drivers, such as drivers with multiple convictions and younger drivers, receive advisory letters soon after completing DIP to remind them to drive more safely. High-risk drivers should also receive a letter after the probation period and warning letters of future sanctions, like license suspension, upon receiving subsequent convictions.

Finally, it was found that a large number of drivers who were suspended continued to drive. Measures should be considered for reducing driving while suspended offenses. Vehicle control measures and California's impoundment program have been found effective in reducing recidivism in terms of subsequent convictions. However, the effectiveness of such measures and programs on crashes has been inconclusive.

While this study provided valuable insights on the effectiveness of Iowa's DIP by gender and age, some limitations of this study should be noted. First, the database used in this study contained information only on the drivers who were instructed to attend DIP. Future data collection efforts could focus on gathering similar type of information for a random sample of drivers (with and without DIP training), which can serve as the "control" group for evaluating DIP's effectiveness. This will facilitate a treatment-control evaluation study. Second, the period of suspension after DIP and the starting date of license suspension were not fully provided, which could affect the program's evaluation results. Future research may also consider conducting this evaluation by type of conviction (speeding, careless driving or other). Finally, the study methodology presented in this study could be applied for the evaluation of other driver education programs such as Iowa's Graduated Driver License Program or other.

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APPENDIX A. ADDITIONAL MATERIAL

Iowa Code Section 321.210 SUSPENSION.

1. The department is authorized to establish rules providing for the suspension of the license of an operator upon thirty days 'notice and without preliminary hearing upon a showing by its records or other sufficient evidence that the licensee:
a. Is an habitually reckless or negligent driver of a motor vehicle.
b. Is an habitual violator of the traffic laws.
c. Is physically or mentally incapable of safely operating a motor vehicle.
d. Has permitted an unlawful or fraudulent use of the license.
e. Has committed an offense or acted in a manner in another state or foreign jurisdiction which in this state would be grounds for suspension or revocation.
f. Has committed a serious violation of the motor vehicle laws of this state.
g. Is subject to a license suspension under section 321.513.

Prior to a suspension taking effect under paragraph *"a"*,*"b"*, *"c"*, *"d"*, *"e"*, or *"f"*, the licensee shall have received thirty days' advance notice of the effective date of the suspension. Notwithstanding the terms of the Iowa administrative procedure Act, chapter 17A, the filing of a petition for judicial review shall, except for suspensions under paragraph *"c"*, operate to stay the suspension pending the determination by the district court.
2. In determining suspension the department shall not consider the following:
a. Violation of motor vehicle equipment standards if repairs are made within seventy-two hours of the violation and satisfactory evidence of repair is immediately sent to the department.
b. Violations of requirements to install and use safety belts, safety harnesses, and child restraint devices under sections 321.445 and 321.446.
c. Parking violations, meaning violation of a local authority parking ordinance or violation of sections 321L.4, 321.366, subsection 6, and 321.354 through 321.361 except section 321.354, subsection 1.
d. The first two speeding violations within any twelve- month period of ten miles per hour or less over the legal speed limit in speed zones having a legal speed limit between thirty-four miles per hour and fifty-six miles per hour.

Section History: Early Form

[C31, 35, § 4960-d35; C39, § **5014.10;** C46, 50, 54, 58, 62, 66, 71, 73, 75, 77, 79, 81, § 321.210; 82 Acts, ch 1100, § 18, 19]

Section History: Recent Form

84 Acts, ch 1016, § 2; 84 Acts, ch 1022, § 1; 86 Acts, ch 1009, § 1; 86 Acts, ch 1220, § 32; 87 Acts, ch 120, §1; 87 Acts, ch 167, §6; 89 Acts, ch 247, §6; 90 Acts, ch 1230, § 54; 96 Acts, ch 1152, § 15;

97 Acts, ch 23, § 33; 97 Acts, ch 104, §16
Referred to in § 321.12, 321.178, 321.180A, 321.189, 321.190, 321.191, 321.194, 321.210C, 321.212, 321.213, 321.215, 321.218, 321.555, 321A.17

Iowa Code Section 321.555

321.555 HABITUAL OFFENDER DEFINED.

As used in this division, *"habitual offender"* means any person who has accumulated convictions for separate and distinct offenses described in subsection 1, 2, or 3, committed after July 1, 1974, for which final convictions have been rendered, as follows:

1. Three or more of the following offenses, either singularly or in combination, within a six-year period:

a. Manslaughter resulting from the operation of a motor vehicle.

b. Operating a motor vehicle in violation of section 321J.2 or its predecessor statute.

c. Driving a motor vehicle while the person's driver's license is suspended, denied, revoked, or barred.

d. Perjury or the making of a false affidavit or statement under oath to the department of public safety.

e. An offense punishable as a felony under the motor vehicle laws of Iowa or any felony in the commission of which a motor vehicle is used.

f. Failure to stop and leave information or to render aid as required by sections 321.261 and 321.263.

g. Eluding or attempting to elude a pursuing law enforcement vehicle in violation of section 321.279.

h. Serious injury by a vehicle in violation of section 707.6A, subsection 4.

2. Six or more of any separate and distinct offenses within a two-year period in the operation of a motor vehicle, which are required to be reported to the department by section 321.491 or chapter 321C, except equipment violations, parking violations as defined in section 321.210, violations of registration laws, violations of sections 321.445 and 321.446, operating a vehicle with an expired license or permit, failure to appear, weights and measures violations and speeding violations of less than fifteen miles per hour over the legal speed limit.

3. The offenses included in subsections 1 and 2 shall be deemed to include offenses under any valid town, city or county ordinance paralleling and substantially conforming to the provisions of the Code concerning such offenses.

Section History: Early Form

[C75, 77, 79, 81, § 321.555; 82 Acts, ch 1167, § 10]

Section History: Recent Form

84 Acts, ch 1016, § 4; 84 Acts, ch 1022, § 9; 86 Acts, ch 1009, § 3; 86 Acts, ch 1220, § 37; 89 Acts, ch 296, § 36; 90 Acts, ch 1230, § 74--76; 93 Acts, ch 87, § 8; 97 Acts, ch 104, §24; 97 Acts, ch 177, § 2; 98 Acts, ch 1073, §9
Referred to in § 321.213, 321.215, 321.556, 321.560

Iowa Code Section 321.218 and 321A.32 Subsection 1
321.218 OPERATING WITHOUT VALID DRIVER'S LICENSE OR WHEN DISQUALIFIED -- PENALTIES.

1. A person whose driver's license or operating privilege has been denied, canceled, suspended, or revoked as provided in this chapter or as provided in section 252J.8 or section 901.5, subsection 10, and who operates a motor vehicle upon the highways of this state while the license or privilege is denied, canceled, suspended, or revoked, commits a simple misdemeanor. In addition to any other penalties, the punishment imposed for a violation of this subsection shall include assessment of a fine of not less than two hundred fifty dollars nor more than one thousand five hundred dollars.
2. The sentence imposed under this section shall not be suspended by the court, notwithstanding section 907.3 or any other statute.
3. The department, upon receiving the record of the conviction of a person under this section upon a charge of operating a motor vehicle while the license of the person is suspended or revoked, shall, except for licenses suspended under section 252J.8, 321.210, subsection 1, paragraph *"c"*, or section 321.210A or 321.513, extend the period of suspension or revocation for an additional like period, and the department shall not issue a new driver's license to the person during the additional period. If the department receives a record of a conviction of a person under this section but the person's driving record does not indicate what the original grounds of suspension were, the period of suspension under this subsection shall be for a period not to exceed six months.
4. A person who operates a commercial motor vehicle upon the highways of this state when disqualified from operating the commercial motor vehicle under section 321.208 or the imminent hazard provisions of 49 C.F.R. § 383.52 commits a serious misdemeanor if a commercial driver's license is required for the person to operate the commercial motor vehicle.
5. The department, upon receiving the record of a conviction of a person under this section upon a charge of operating a commercial motor vehicle while the person is disqualified, shall extend the period of disqualification for an additional like period or for the time period specified in section 321.208, whichever is longer.

Section History: Early Form

[C31, 35, § 4960-d34, -d51; C39, § **5015.03;** C46, 50, 54, 58, 62, 66, 71, 73, 75, 77, 79, 81, § 321.218; 82 Acts, ch 1167, § 4]

Section History: Recent Form

84 Acts, ch 1142, § 1; 85 Acts, ch 195, § 36; 86 Acts, ch 1220, § 34; 89 Acts, ch 83, §43; 90 Acts, ch 1230, § 60; 93 Acts, ch 164, § 4; 95 Acts, ch 48, §4; 96 Acts, ch 1090, § 6, 7; 97 Acts, ch 104, §17; 98 Acts, ch 1073, § 9; 99 Acts, ch 153, §2; 2005 Acts, ch 8, §28; 2006 Acts, ch 1030, §36
Referred to in § 321.211A, 321J.4B, 805.6

321A.32 OTHER VIOLATIONS -- PENALTIES.

1. Any person whose license or registration or nonresident's operating privilege has been suspended, denied, or revoked under this chapter or continues to remain suspended or revoked under this chapter, and who, during such suspension, denial, or revocation, or during such continuing suspension or continuing revocation, drives any motor vehicle upon any highway or knowingly permits any motor vehicle owned by such person to be operated by another upon any highway, except as permitted under this chapter, shall be guilty of a simple misdemeanor. In addition to any other penalties, the punishment imposed for a violation of this subsection shall include assessment of a fine of not less than two hundred fifty dollars nor more than one thousand five hundred dollars.
2. Any person willfully failing to return license or registration as required in section 321A.31 shall be guilty of a simple misdemeanor.
3. A person who forges or, without authority, signs a notice provided for under section 321A.5 that a policy or bond is in effect, or any evidence of financial responsibility, or any evidence of financial liability coverage as defined in section 321.1, or who files or offers for filing any such notice or evidence knowing or having reason to believe that it is forged or signed without authority, is guilty of a serious misdemeanor.
4. Any person who shall violate any provision of this chapter for which no penalty is otherwise provided shall be guilty of a serious misdemeanor.

Section History: Early Form

[C31, 35, § 5079-c7; C39, § **5021.05;** C46, § 321.279; C50, 54, 58, 62, 66, 71, 73, 75, 77, 79, 81, § 321A.32]

Section History: Recent Form

84 Acts, ch 1142, § 2; 97 Acts, ch 139, §10, 17, 18; 98 Acts, ch 1121, §8; 99 Acts, ch 153, §5
Referred to in § 321J.4B, 805.6

Iowa Code Chapter 321J.2

321J.2 OPERATING WHILE UNDER THE INFLUENCE OF ALCOHOL OR A DRUG OR WHILE HAVING AN ALCOHOL CONCENTRATION OF .08 OR MORE (OWI).

1. A person commits the offense of operating while intoxicated if the person operates a motor vehicle in this state in any of the following conditions:
a. While under the influence of an alcoholic beverage or other drug or a combination of such substances.
b. While having an alcohol concentration of .08 or more.
c. While any amount of a controlled substance is present in the person, as measured in the person's blood or urine.
2. A person who violates subsection 1 commits:
a. A serious misdemeanor for the first offense, punishable by all of the following:
(1) Imprisonment in the county jail for not less than forty-eight hours, to be served as ordered by the court, less credit for any time the person

was confined in a jail or detention facility following arrest or for any time the person spent in a court-ordered operating-while-intoxicated program that provides law enforcement security. However, the court, in ordering service of the sentence and in its discretion, may accommodate the defendant's work schedule.

(2) Assessment of a fine of one thousand two hundred fifty dollars. However, in the discretion of the court, if no personal or property injury has resulted from the defendant's actions, the court may waive up to six hundred twenty-five dollars of the fine when the defendant presents to the court at the end of the minimum period of ineligibility, a temporary restricted license issued pursuant to section 321J.20. As an alternative to a portion or all of the fine, the court may order the person to perform unpaid community service.

(3) Revocation of the person's driver's license pursuant to section 321J.4, subsection 1, section 321J.9, or section 321J.12, subsection 2, which includes a minimum revocation period of one hundred eighty days, and may involve a revocation period of one year. A revocation under section 321J.9 includes a minimum period of ineligibility for a temporary restricted license of ninety days.

(a) A defendant whose alcohol concentration is .08 or more but not more than .10 shall not be eligible for any temporary restricted license for at least thirty days if a test was obtained and an accident resulting in personal injury or property damage occurred. The defendant shall be ordered to install an ignition interlock device of a type approved by the commissioner of public safety on all vehicles owned or operated by the defendant if the defendant seeks a temporary restricted license. There shall be no such period of ineligibility if no such accident occurred, and the defendant shall not be ordered to install an ignition interlock device.

(b) A defendant whose alcohol concentration is more than .10 shall not be eligible for any temporary restricted license for at least thirty days if a test was obtained, and an accident resulting in personal injury or property damage occurred or the defendant's alcohol concentration exceeded .15. There shall be no such period of ineligibility if no such accident occurred and the defendant's alcohol concentration did not exceed .15. In either case, where a defendant's alcohol concentration is more than .10, the defendant shall be ordered to install an ignition interlock device of a type approved by the commissioner of public safety on all vehicles owned or operated by the defendant if the defendant seeks a temporary restricted license.

(4) Assignment to substance abuse evaluation and treatment, a course for drinking drivers, and, if available and appropriate, a reality education substance abuse prevention program pursuant to subsection 3.

b. An aggravated misdemeanor for a second offense, and shall be imprisoned in the county jail or community-based correctional facility not less than seven days, and assessed a fine of not less than one thousand eight hundred seventy-five dollars nor more than six thousand two hundred fifty dollars.

c. A class "D" felony for a third offense and each subsequent offense, and shall be committed to the custody of the director of the department of corrections for an indeterminate term not to exceed five years, shall be confined for a mandatory minimum term of thirty days, and shall be assessed a fine of not less than three thousand one hundred twenty-five dollars nor more than nine thousand three hundred seventy-five dollars.

(1) If the court does not suspend a person's sentence of commitment to the custody of the director of the department of corrections under this paragraph *"c"*, the person shall be assigned to a facility pursuant to section 904.513.
(2) If the court suspends a person's sentence of commitment to the custody of the director of the department of corrections under this paragraph *"c"*, the court shall order the person to serve not less than thirty days nor more than one year in the county jail, and the person may be committed to treatment in the community under section 907.6.
3. *a.* Notwithstanding the provisions of sections 901.5 and 907.3, the court shall not defer judgment or sentencing, or suspend execution of any mandatory minimum sentence of incarceration applicable to the defendant under subsection 2, and shall not suspend execution of any other part of a sentence not involving incarceration imposed pursuant to subsection 2, if any of the following apply:
(1) If the defendant's alcohol concentration established by the results of an analysis of a specimen of the defendant's blood, breath, or urine withdrawn in accordance with this chapter exceeds .15, regardless of whether or not the alcohol concentration indicated by the chemical test minus the established margin of error inherent in the device or method used to conduct the test equals an alcohol concentration of .15 or more.
(2) If the defendant has previously been convicted of a violation of subsection 1 or a statute in another state substantially corresponding to subsection 1.
(3) If the defendant has previously received a deferred judgment or sentence for a violation of subsection 1 or for a violation of a statute in another state substantially corresponding to subsection 1.

(4) If the defendant refused to consent to testing requested in accordance with section 321J.6.
(5) If the offense under this chapter results in bodily injury to a person other than the defendant.
b. All persons convicted of an offense under subsection 2 shall be ordered, at the person's expense, to undergo, prior to sentencing, a substance abuse evaluation.
c. Where the program is available and is appropriate for the convicted person, a person convicted of an offense under subsection 2 shall be ordered to participate in a reality education substance abuse prevention program as provided in section 321J.24.
d. A minimum term of imprisonment in a county jail or community-based correctional facility imposed on a person convicted of a second or subsequent offense under subsection 2 shall be served on consecutive days. However, if the sentencing court finds that service of the full minimum term on consecutive days would work an undue hardship on the person, or finds that sufficient jail space is not available and is not reasonably expected to become available within four months after sentencing to incarcerate the person serving the minimum sentence on consecutive days, the court may order the person to serve the minimum term in segments of at least forty-eight hours and to perform a specified number of hours of unpaid community service as deemed appropriate by the sentencing court.
4. In determining if a violation charged is a second or subsequent offense for purposes of criminal sentencing or license revocation under this chapter:

a. Any conviction or revocation deleted from motor vehicle operating records pursuant to section 321.12 shall not be considered as a previous offense.
b. Deferred judgments entered pursuant to section 907.3 for violations of this section shall be counted as previous offenses.
c. Convictions or the equivalent of deferred judgments for violations in any other states under statutes substantially corresponding to this section shall be counted as previous offenses. The courts shall judicially notice the statutes of other states which define offenses substantially equivalent to the one defined in this section and can therefore be considered corresponding statutes. Each previous violation on which conviction or deferral of judgment was entered prior to the date of the violation charged shall be considered and counted as a separate previous offense.
5. A person shall not be convicted and sentenced for more than one violation of this section for actions arising out of the same event or occurrence, even if the event or occurrence involves more than one of the conditions specified in subsection 1.
6. The clerk of the district court shall immediately certify to the department a true copy of each order entered with respect to deferral of judgment, deferral of sentence, or pronouncement of judgment and sentence for a defendant under this section.
7. *a.* This section does not apply to a person operating a motor vehicle while under the influence of a drug if the substance was prescribed for the person and was taken under the prescription and in accordance with the directions of a medical practitioner as defined in chapter 155A or if the substance was dispensed by a pharmacist without a prescription pursuant to the rules of the board of pharmacy, if there is no evidence of the consumption of alcohol and the medical practitioner or pharmacist had not directed the person to refrain from operating a motor vehicle.
b. When charged with a violation of subsection 1, paragraph *"c"*, a person may assert, as an affirmative defense, that the controlled substance present in the person's blood or urine was prescribed or dispensed for the person and was taken in accordance with the directions of a practitioner and the labeling directions of the pharmacy, as that person and place of business are defined in section 155A.3.
8. In any prosecution under this section, evidence of the results of analysis of a specimen of the defendant's blood, breath, or urine is admissible upon proof of a proper foundation.
a. The alcohol concentration established by the results of an analysis of a specimen of the defendant's blood, breath, or urine withdrawn within two hours after the defendant was driving or in physical control of a motor vehicle is presumed to be the alcohol concentration at the time of driving or being in physical control of the motor vehicle.
b. The presence of a controlled substance or other drug established by the results of analysis of a specimen of the defendant's blood or urine withdrawn within two hours after the defendant was driving or in physical control of a motor vehicle is presumed to show the presence of such controlled substance or other drug in the defendant at the time of driving or being in physical control of the motor vehicle.
c. The department of public safety shall adopt nationally accepted standards for determining detectable levels of controlled substances in the division of criminal investigation's initial

laboratory screening test for controlled substances.
9. *a.* In addition to any fine or penalty imposed under this chapter, the court shall order a defendant convicted of or receiving a deferred judgment for a violation of this section to make restitution for damages resulting directly from the violation, to the victim, pursuant to chapter 910. An amount paid pursuant to this restitution order shall be credited toward any adverse judgment in a subsequent civil proceeding arising from the same occurrence. However, other than establishing a credit, a restitution proceeding pursuant to this section shall not be given evidentiary or preclusive effect in a subsequent civil proceeding arising from the same occurrence.
b. The court may order restitution paid to any public agency for the costs of the emergency response resulting from the actions constituting a violation of this section, not exceeding five hundred dollars per public agency for each such response. For the purposes of this paragraph, *"emergency response"* means any incident requiring response by fire fighting, law enforcement, ambulance, medical, or other emergency services. A public agency seeking such restitution shall consult with the county attorney regarding the expenses incurred by the public agency, and the county attorney may include the expenses in the statement of pecuniary damages pursuant to section 910.3.
10. In any prosecution under this section, the results of a chemical test shall not be used to prove a violation of subsection 1, paragraph *"b"* or *"c"*, if the alcohol, controlled substance, or other drug concentration indicated by the chemical test minus the established margin of error inherent in the device or method used to conduct the chemical test does not equal or exceed the level prohibited by subsection 1, paragraph *"b"* or *"c"*.

Section History: Recent Form

86 Acts, ch 1220, § 2; 87 Acts, ch 118, § 4; 87 Acts, ch 215, § 46; 90 Acts, ch 1233, § 20; 90 Acts, ch 1251, § 33; 97 Acts, ch 177, §4, 5; 98 Acts, ch 1073, § 9; 98 Acts, ch 1100, §50; 98 Acts, ch 1138, § 2, 3, 11--13, 37; 99 Acts, ch 96, §36; 2000 Acts, ch 1118, §1; 2000 Acts, ch 1135, §1; 2002 Acts, ch 1042, §1; 2003 Acts, ch 60, §1, 2; 2003 Acts, ch 179, §120; 2003 Acts, 1st Ex, ch 2, §48, 209; 2006 Acts, ch 1010, § 90; 2006 Acts, ch 1166, § 1--3; 2007 Acts, ch 10, §174
Referred to in § 232.22, 321.12, 321.213, 321.279, 321.555, 321J.2A, 321J.2B, 321J.3, 321J.4, 321J.4B, 321J.5, 321J.6, 321J.8, 321J.9, 321J.10, 321J.10A, 321J.12, 321J.13, 321J.15, 321J.16, 321J.17, 321J.20, 321J.22, 321J.24, 321J.25, 602.8102(51), 707.6A, 804.31, 902.3, 907.3, 910.1, 910.2, 910.3, 915.80
For provisions relating to third offense OWI driver's license revocations and restoration of driving privileges, see 99 Acts, ch 153, §25

Iowa Code 321.263
321.263 INFORMATION AND AID -- LEAVING SCENE OF ACCIDENT.

1. The driver of a vehicle involved in an accident resulting in injury to or death of a person or damage to a vehicle which is driven or attended by a person shall give the driver's name, address, and the registration number of the vehicle the driver is driving and shall upon request and if available exhibit the driver's driver's license to the person struck, the driver or occupant of, or the person attending the vehicle involved in the accident and shall render to a person injured in the accident reasonable assistance, including the transporting or arranging for the transporting of the person for medical treatment if it is apparent that medical treatment is necessary or if transportation for medical treatment is requested by the injured person.

2. If the accident causes the death of a person, all surviving drivers shall remain at the scene of the accident except to seek necessary aid or to report the accident to law enforcement authorities. Before leaving the scene of the fatal accident, each surviving driver shall leave the surviving driver's driver's license, automobile registration receipt, or other identification data at the scene of the accident. After leaving the scene of the accident, a surviving driver shall promptly report the accident to law enforcement authorities, and shall immediately return to the scene of the accident or inform the law enforcement authorities where the surviving driver can be located.

Section History: Early Form

[S13, § 1571-m23; C24, 27, 31, 35, § 5072, 5079; C39, § **5020.03;** C46, 50, 54, 58, 62, 66, 71, 73, 75, 77, 79, 81, § 321.263]

Section History: Recent Form

90 Acts, ch 1230, §68; 98 Acts, ch 1073, §9
Referred to in § 321.228, 321.261, 321.262, 321.555

APPENDIX B. DATA

Table B.1 DIP Location

#	Abbreviation	Community College	City
1	NICC	Northeast Iowa Community College Calmar	CALMAR
2	NICC	Northeast Iowa Community College Peosta	PEOSTA
3	NIACC	North Iowa Area Community College	MASON CITY
4	ILCC	Iowa Lakes Community College	EMMETSBURG
5	NCC	Northwest Iowa Community College	SHELDON
6	ICCC	Iowa Central Community College	FORT DODGE
7	IVCCD	Iowa Valley Community College District	MARSHALLTOWN
8	HCC	Hawkeye Community College	WATERLOO
9	EICCD	Eastern Iowa Community College District	BETTENDORF
10	KCC	Kirkwood Community College	CEDAR RAPIDS
11	DMACC	Des Moines Area Community College	ANKENY
12	WITCC	Western Iowa Tech Community College Denison	DENISON
13	WITCC	Western Iowa Tech Community College Sioux City	SIOUX CITY
14	IWCC	Iowa Western Community College	COUNCIL BLUFFS
15	SWCC	Southwestern Community College	CRESTON
16	IHCC	Indian Hills Community College	OTTUMWA
17	SECC	Southeastern Community College	WEST BURLINGTON

Table B.2 Description of Conviction Reason Codes

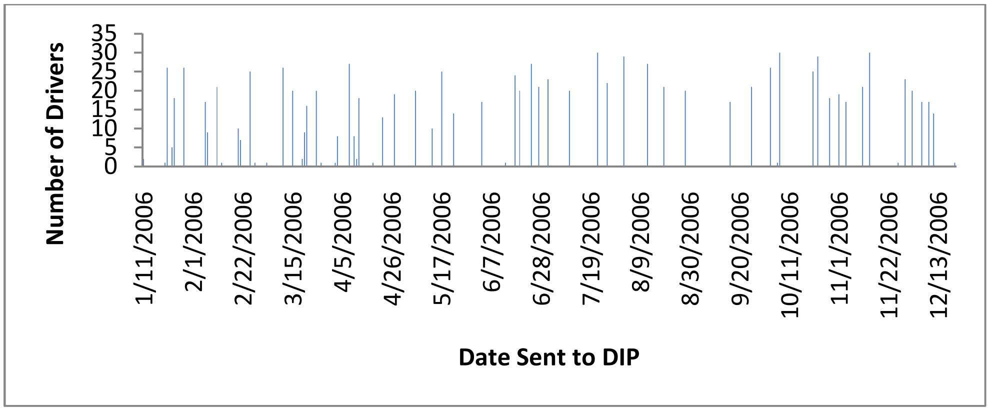
Reason Code	Description	Reason Code	Description
2	Allow unauthorized person to drive	42	Improper start
4	Careless driving	43	Improper turn
6	Crossing fire hose	47	Injurious material on highway
9	Drag Racing	49	Interfere with signs or signals (321.260)
10	Driving where prohibited	51	Lamps on parked vehicle (321.395)
13	Driving wrong way on one way street	60	No driver's license
14	Driving too slow	61	Obstructed vision
15	Driving without headlamps or with park lamps	65	False statement under oath
18	Fail to yield ½ of roadway	67	Reckless driving
23	Fail to obey officer	68	Passing school bus
24	Violation of accident requirements	71	Violation of motorcycle or moped
25	Fail to dim headlights	72	Speed
27	Fail to yield right of way	85	Operating without owner's consent
28	Fail to yield to emergency vehicle	91	Offense by owner (conviction)
29	Fail to obey traffic sign/signal	93	Following emergency vehicle
30	Following too close	96	Speed (10 mph & under 35-55 mph zone)
31	Fail to have vehicle under control	120	Open container
34	Improper backing	122	Violation of impoundment or immobilization (321J.4B)
35	Improper lane (changing lanes)	135	Leaving the scene of PD ACC (321.263)
40	Improper passing	136	Improper lane use
41	Improper signal or failed to signal	167	Violation resulting in fatal accident (in CMV)
*12	Driving while suspended, denied, cancelled, revoked	*108	Driving while barred (in CMV)
*17	Eluding	*109	Violating out-of-service

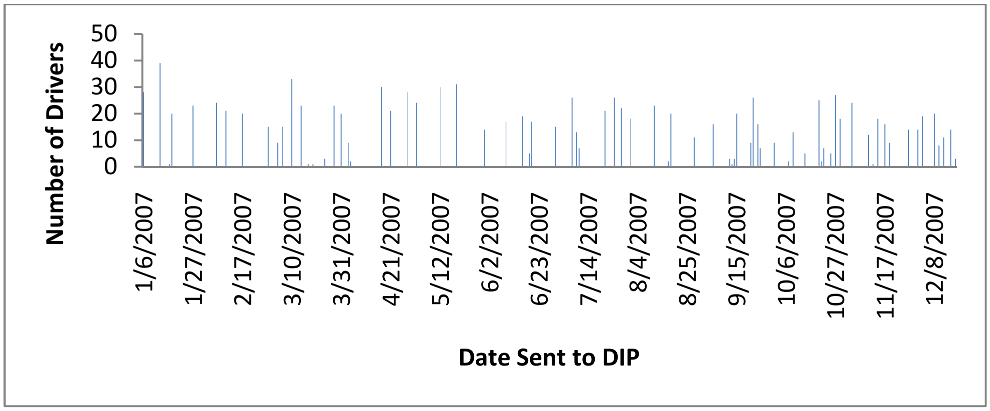
			order (CMV)
*21	Felony in use of motor vehicle	*110	Vehicular homicide or serious injury – OWI
*52	Larceny of motor vehicle	*111	Unlawful use of license – alcohol related
*54	Leaving scene of personal injury accident	*118	Possession alcohol under legal age
*56	Manslaughter	*138	GDL violation
*57	Vehicular homicide or serious injury	*143	Unlawful use of license – Tobacco
*62	Operating while intoxicated	*144	Fail to stop before crossing railroad
*63	Ignition interlock device	*145	Fail to slow/check RR crossing
*70	Deferred judgment OWI	*146	Fail to stop/RR track not clear
*81	Violation of restricted license	*147	Blocks RR crossing
*83	Violation of school license	*148	Disobeys traffic control at RR
*89	Violation of moped law	*149	Not enough clearance/RR
*102	Felony or aggravated misdemeanor involving disp/dist/mfg of drugs (CMV)	*150	Violation of RR crossing
*103	No commercial driver's license (321.174(3))	*153	Violation of RR crossing
*104	Driving while disqualified (in CMV)	*166	Theft of motor fuel

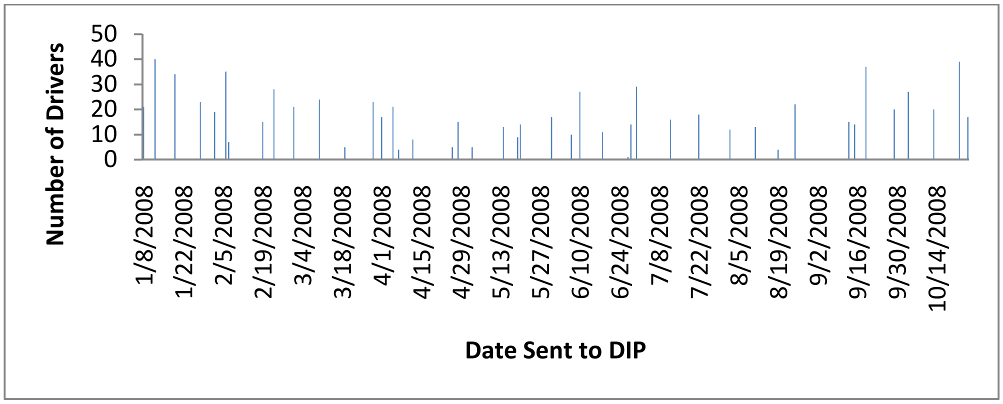
"*****" Can be reason for conviction or sanction.

APPENDIX C. DISTRIBUTION OF DRIVER POPULATION BY DIP DATE AND DIP LOCATION

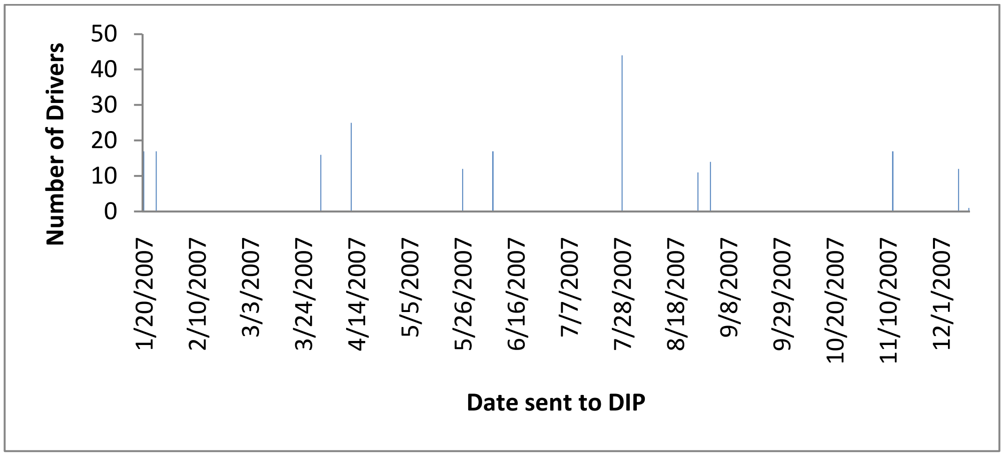
- **Des Moines Area Community College, Ankeny**

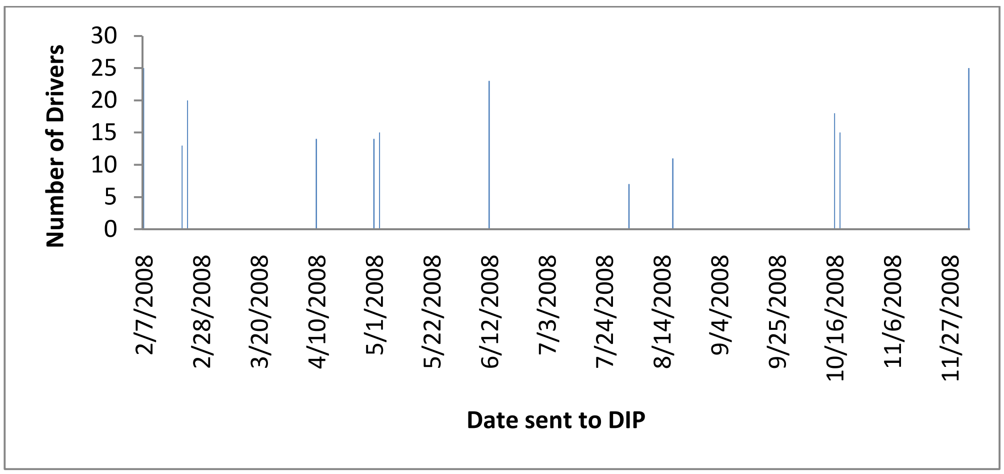




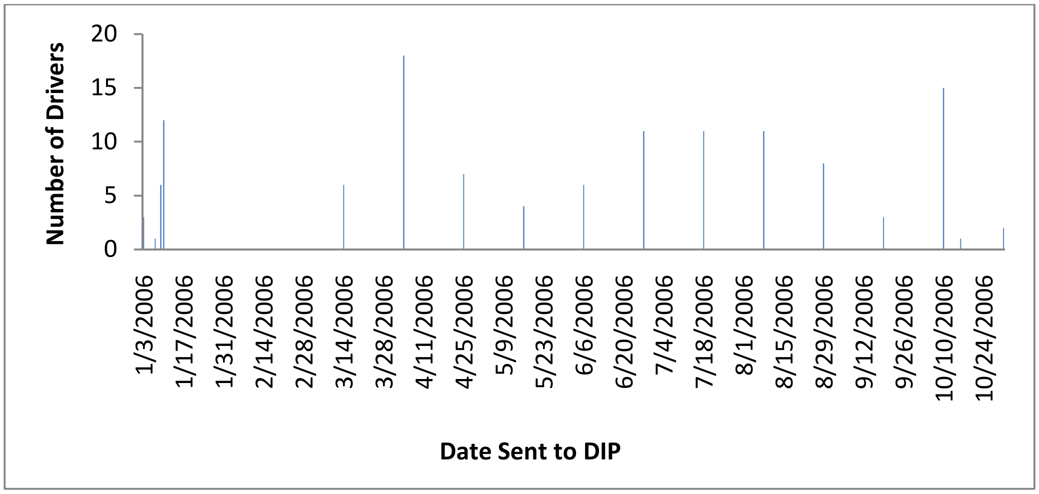


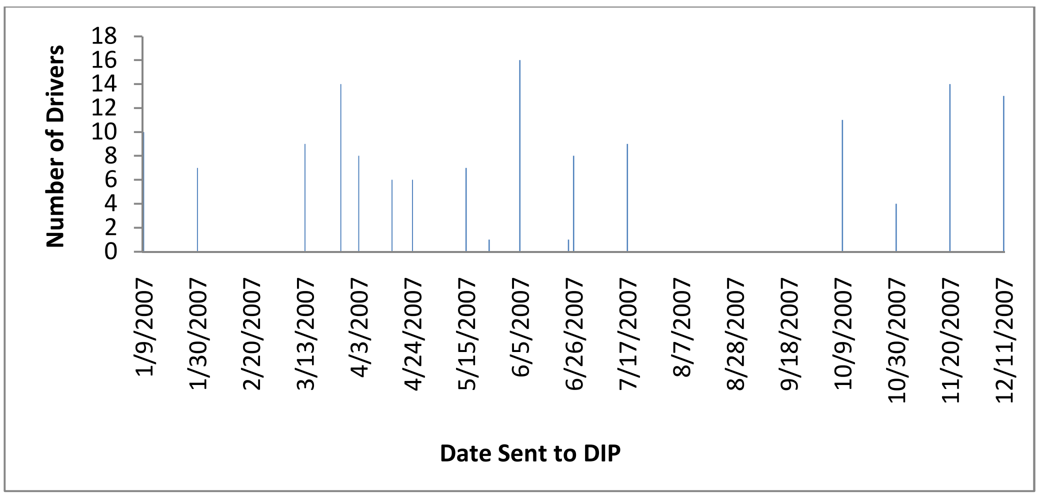
- **Western Iowa Tech Community College, Denison/Sioux City**

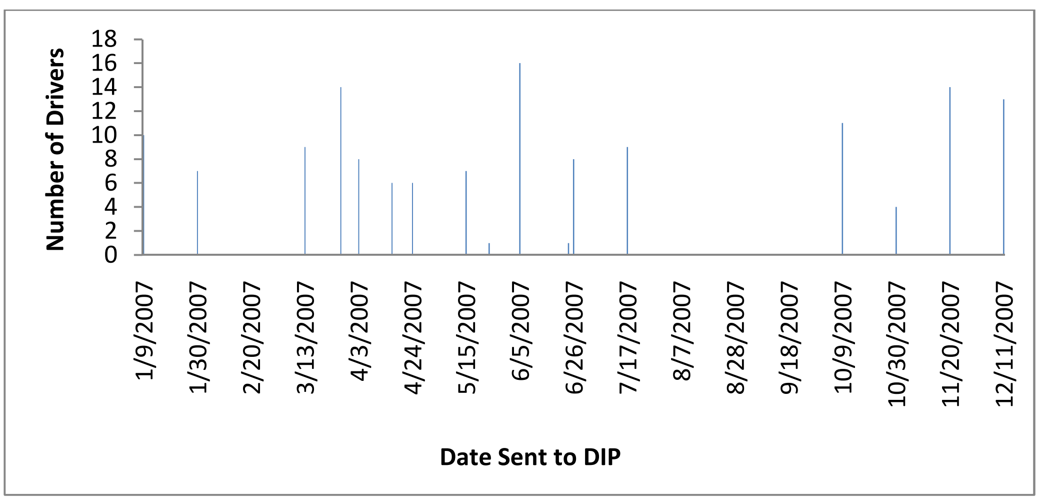




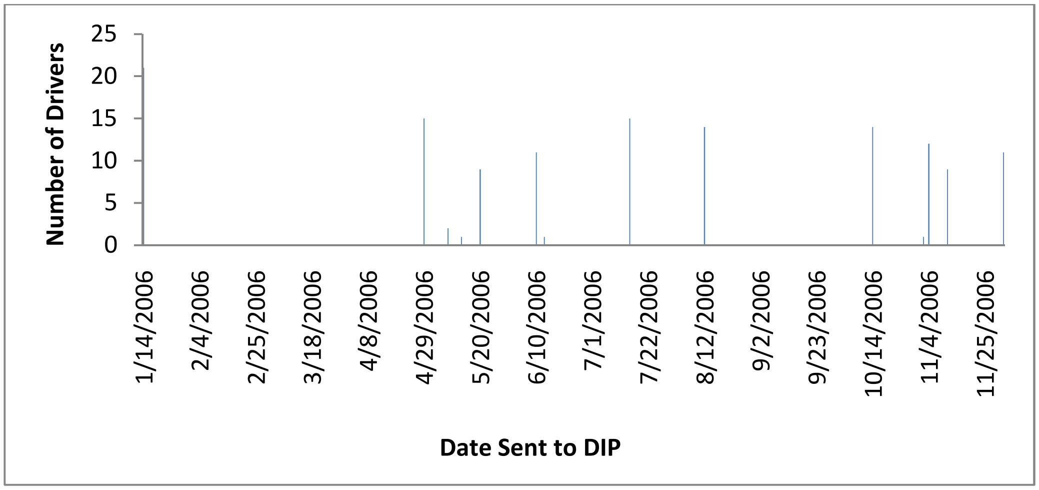
- **Indian Hills Community College, Ottumwa**

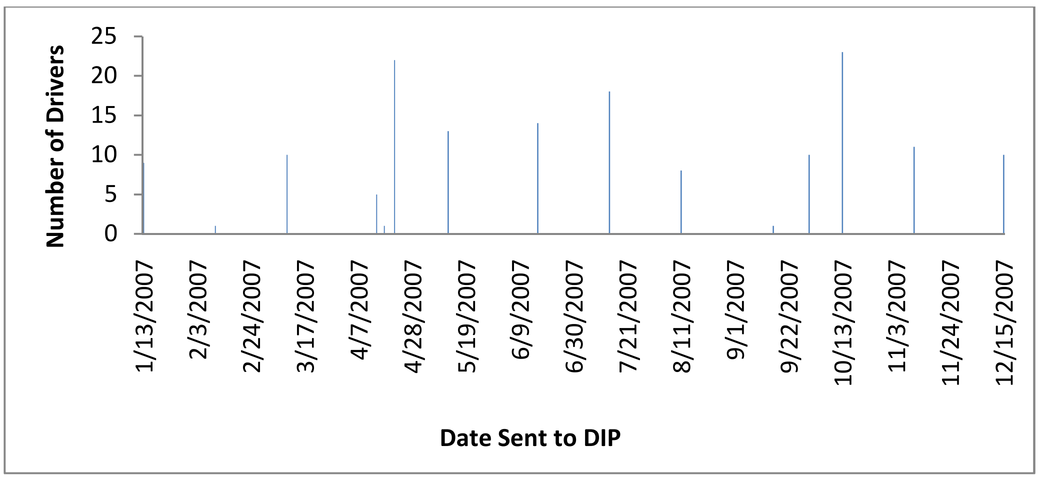


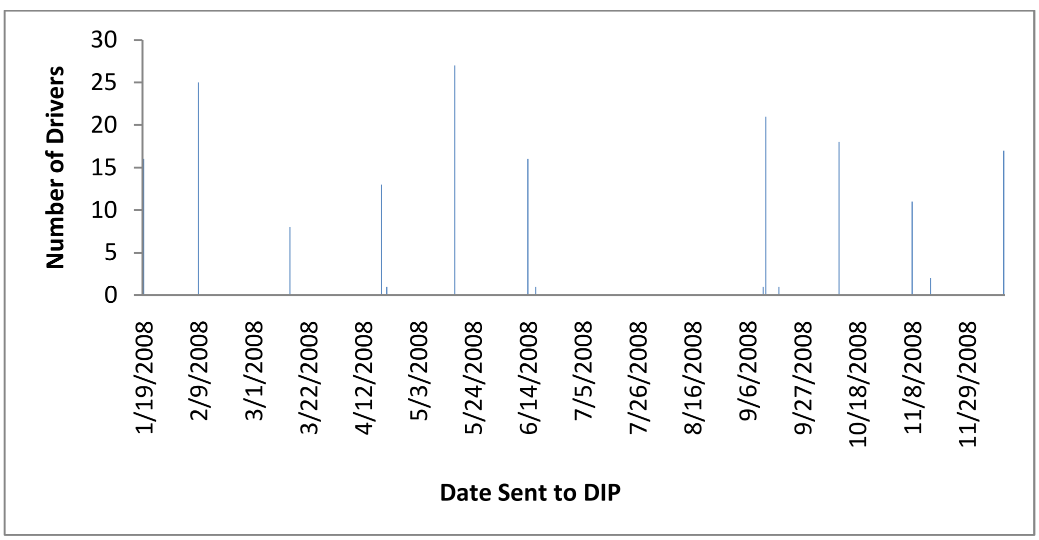




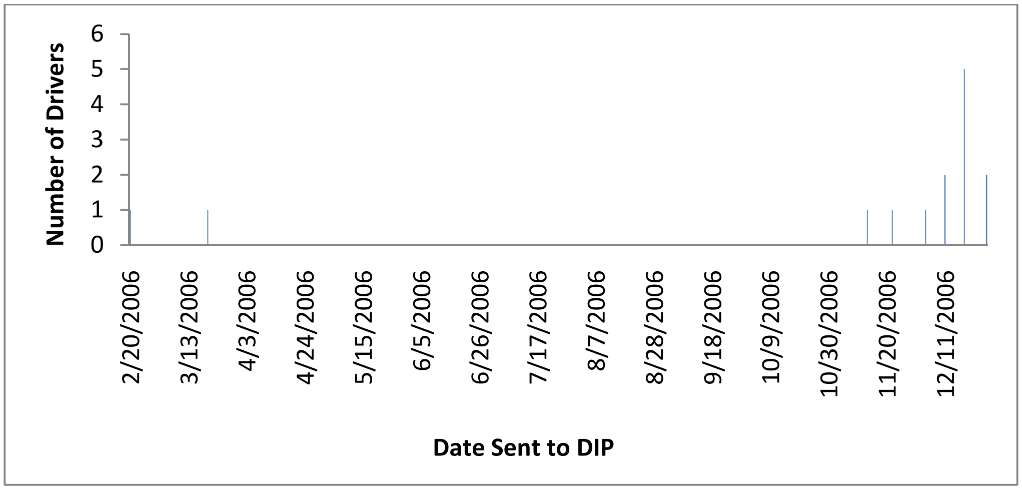
- **Southeastern Community College, West Burlington**

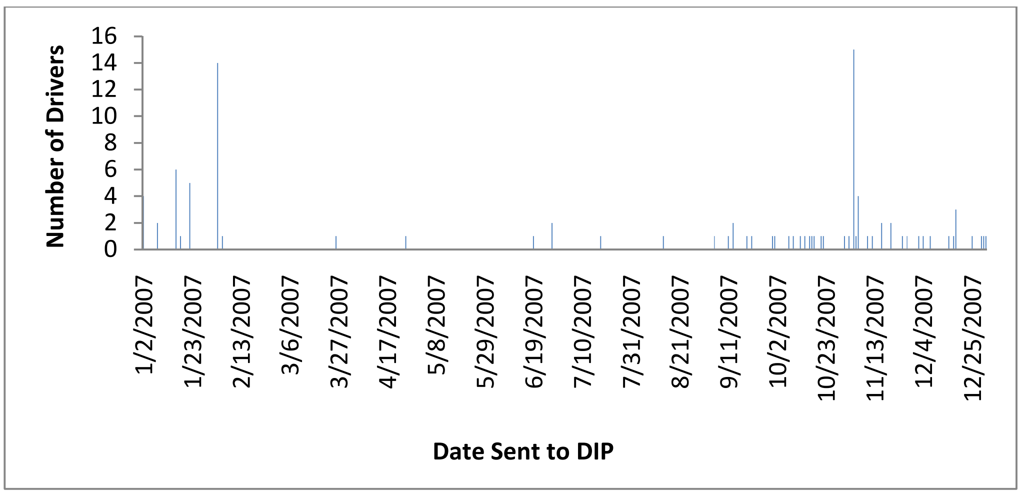


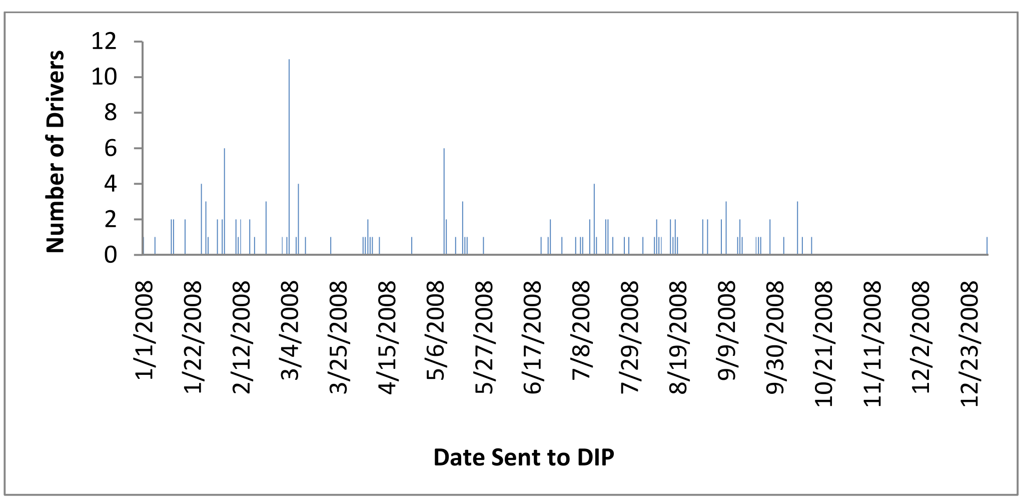




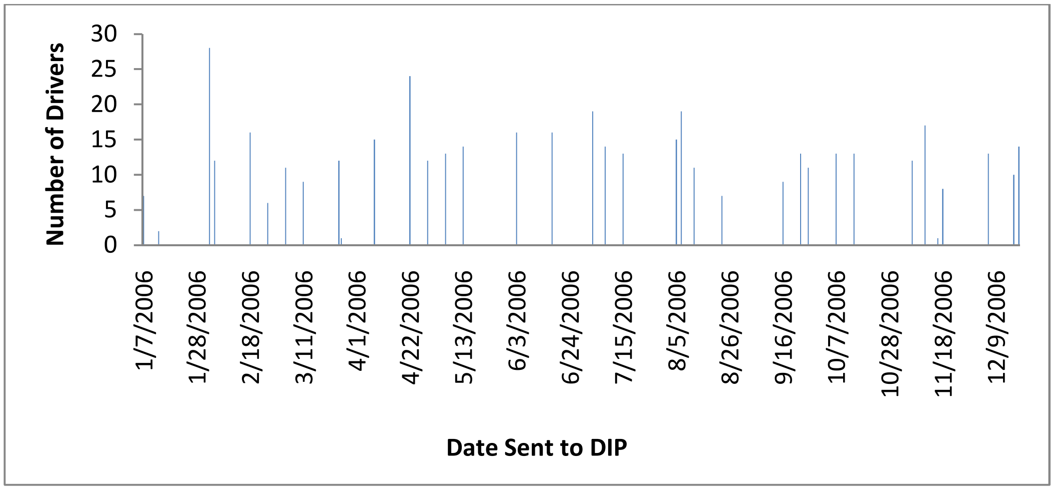
- **Hawkeye Community College, Waterloo**

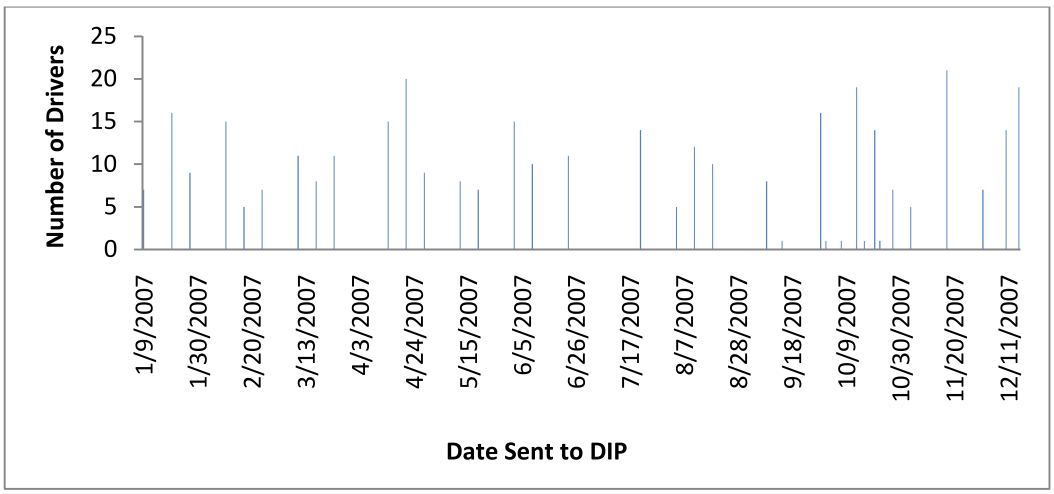


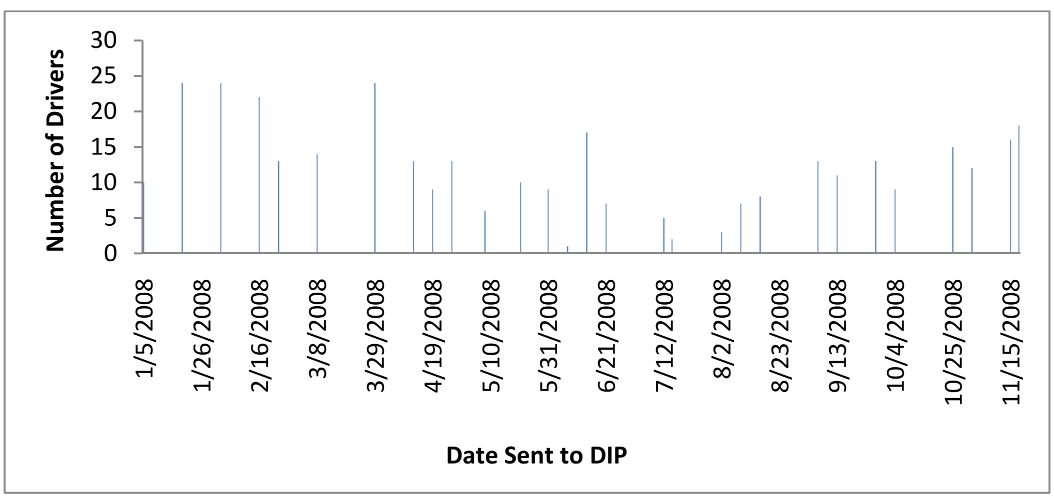




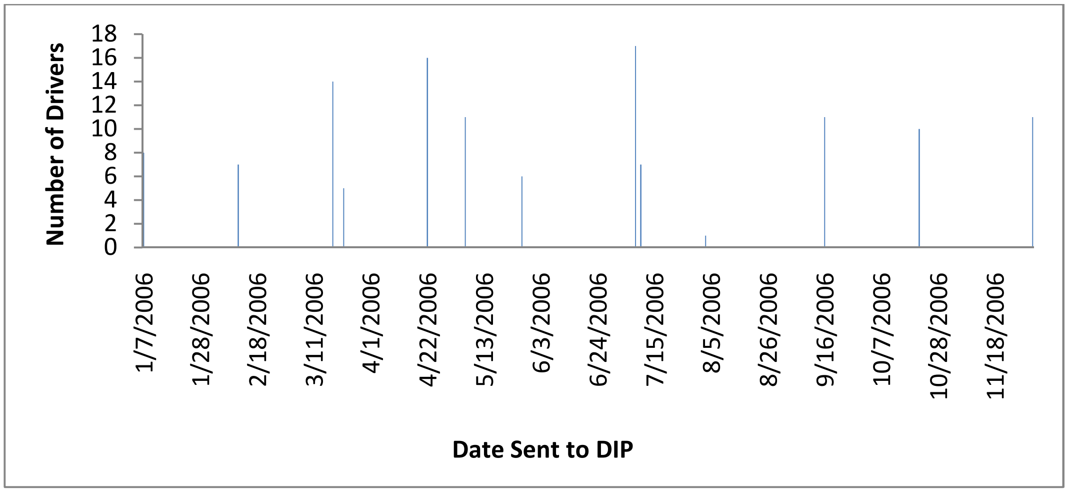
- **Eastern Iowa Community College District, Bettendorf**

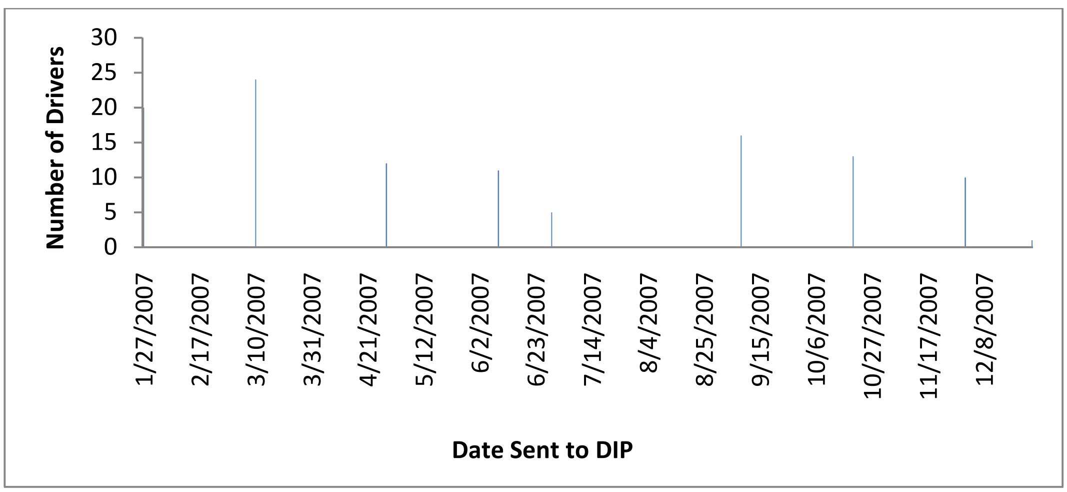


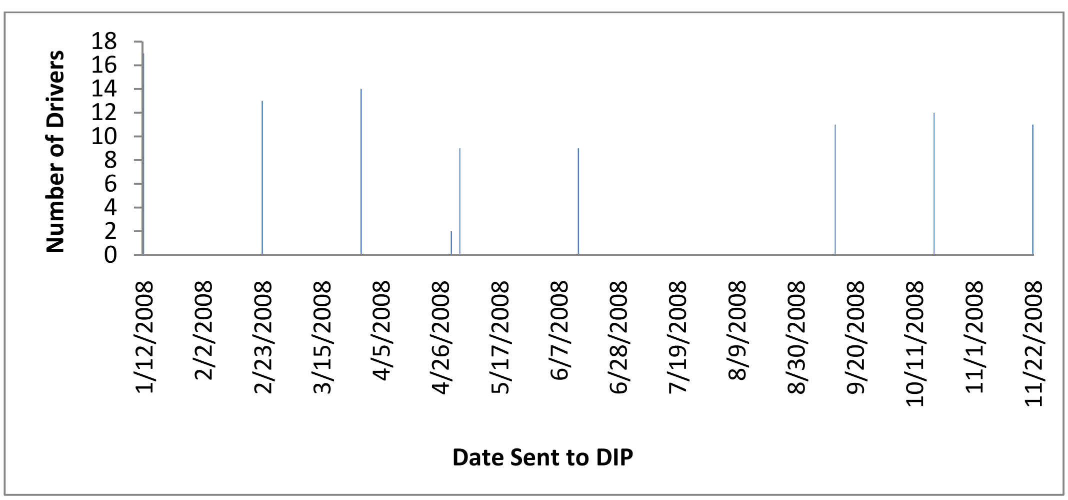




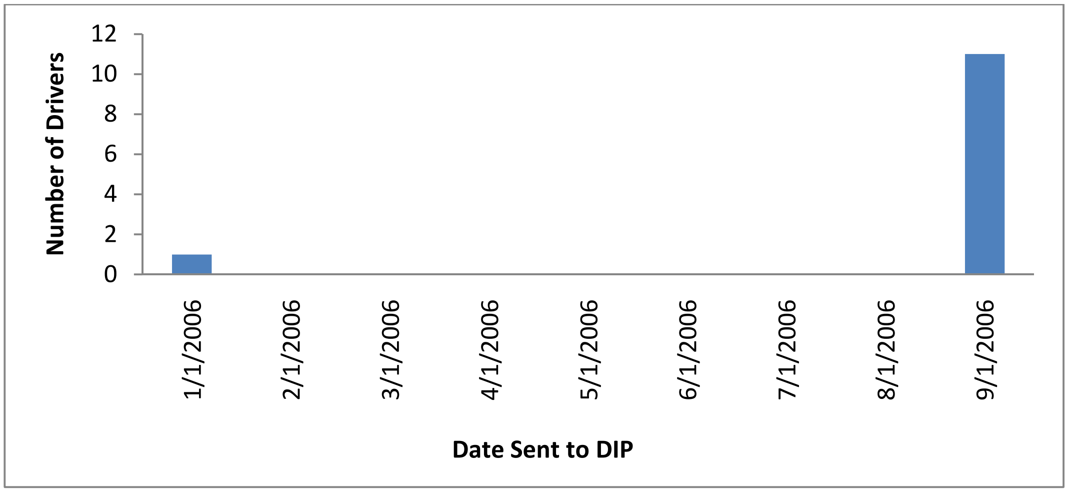
- **Iowa Central Community College, Fort Dodge**

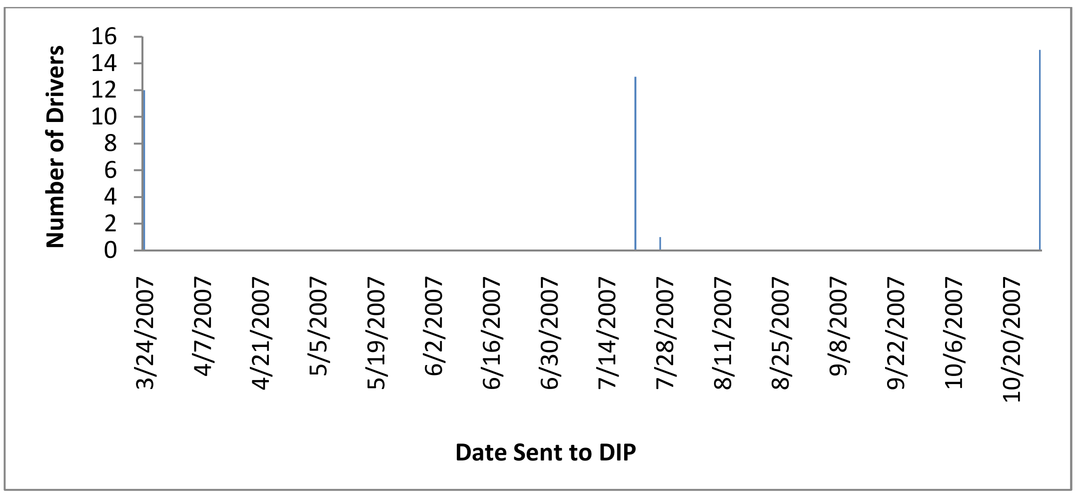


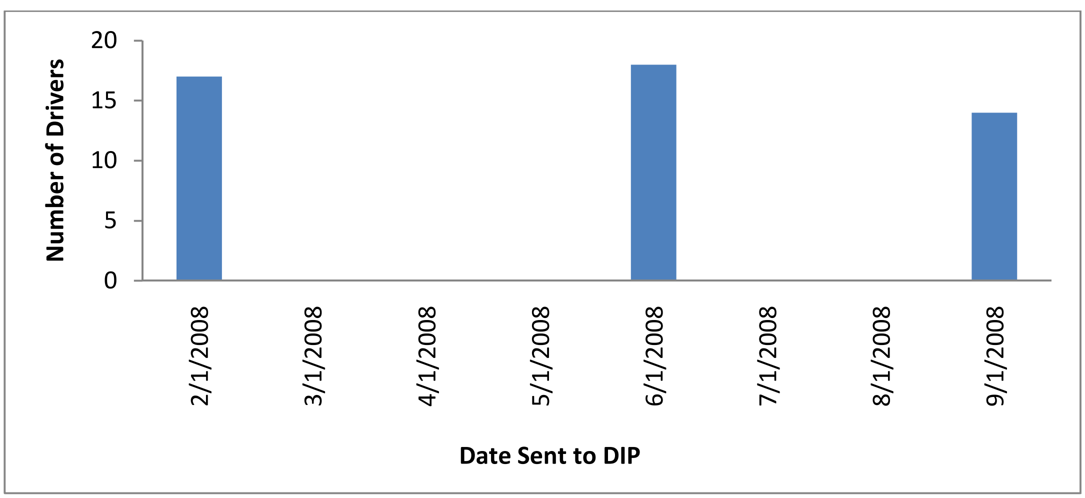




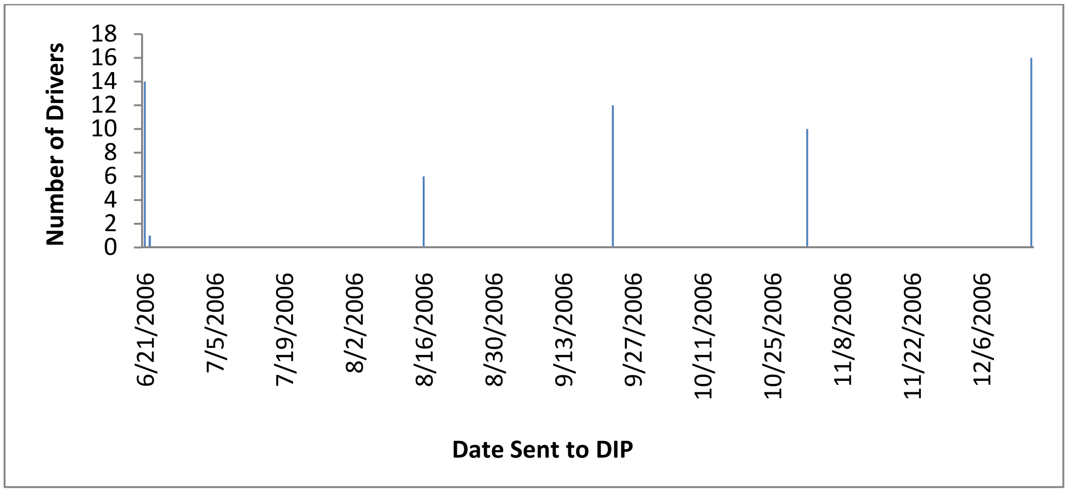
- **Iowa Lakes Community College, Emmetsburg**

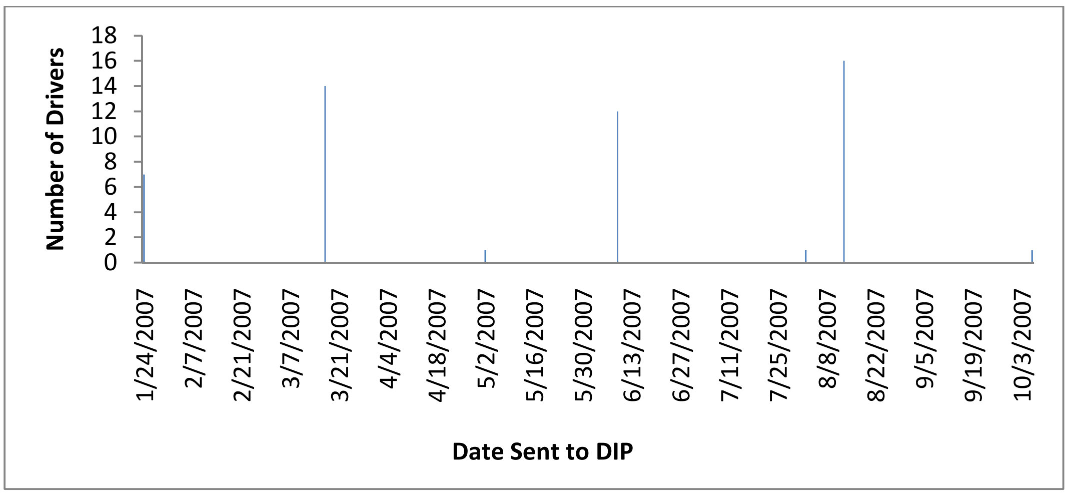


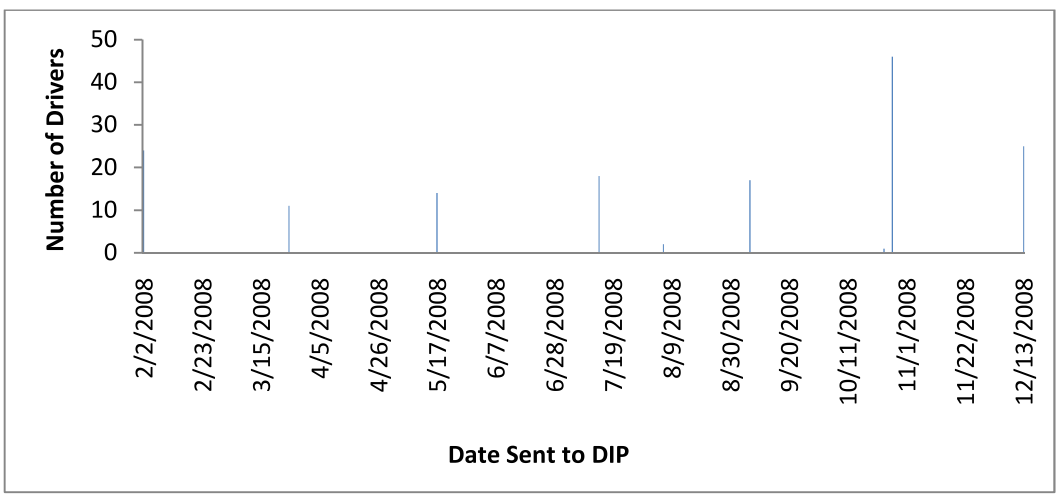




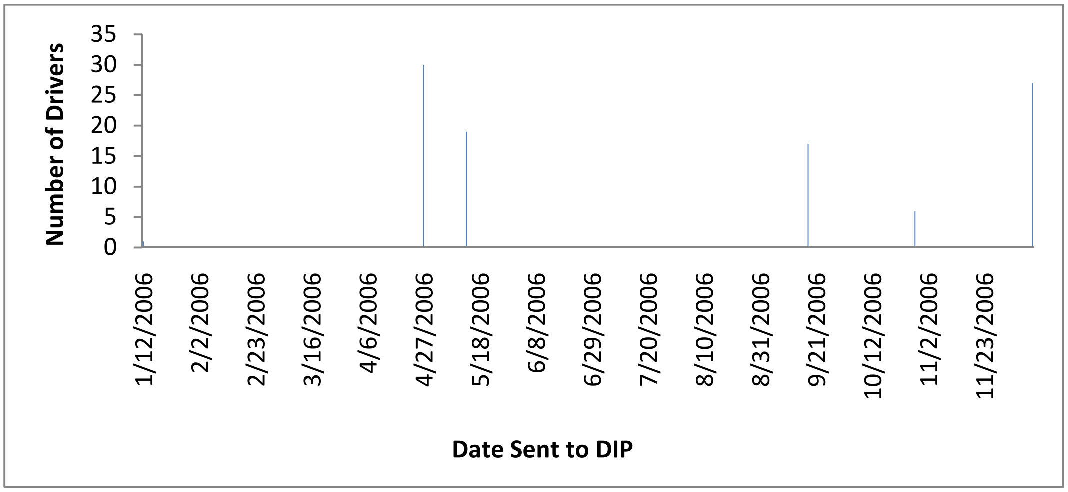
- **Iowa Valley Community College District, Marshalltown**

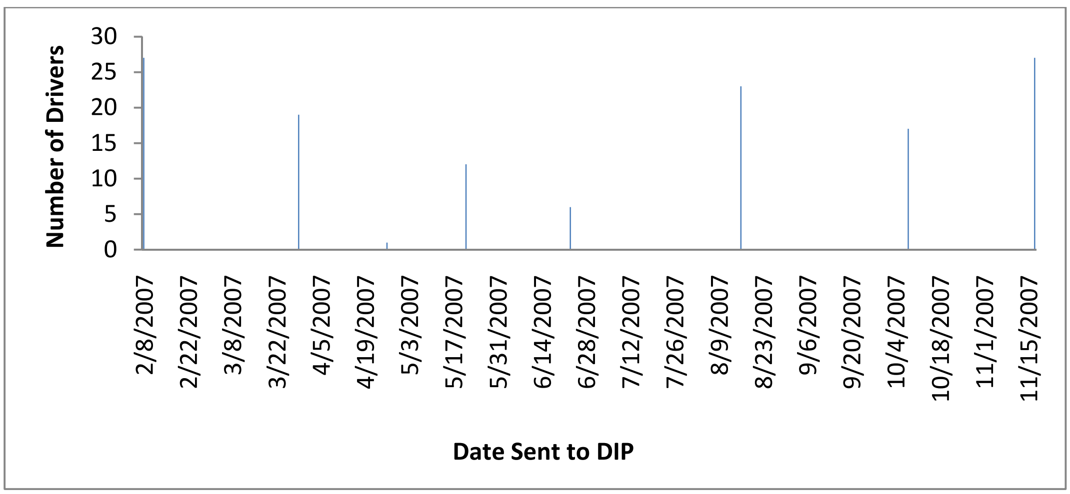


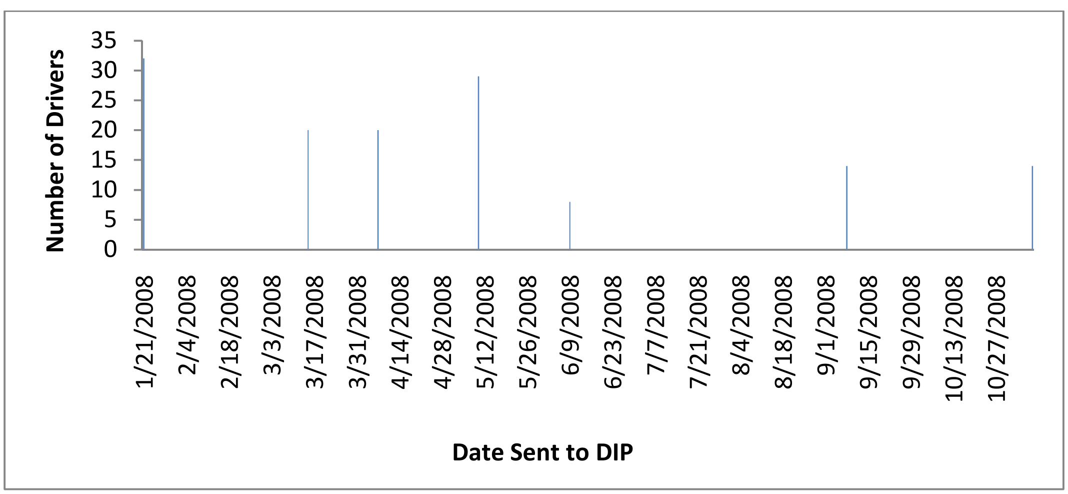




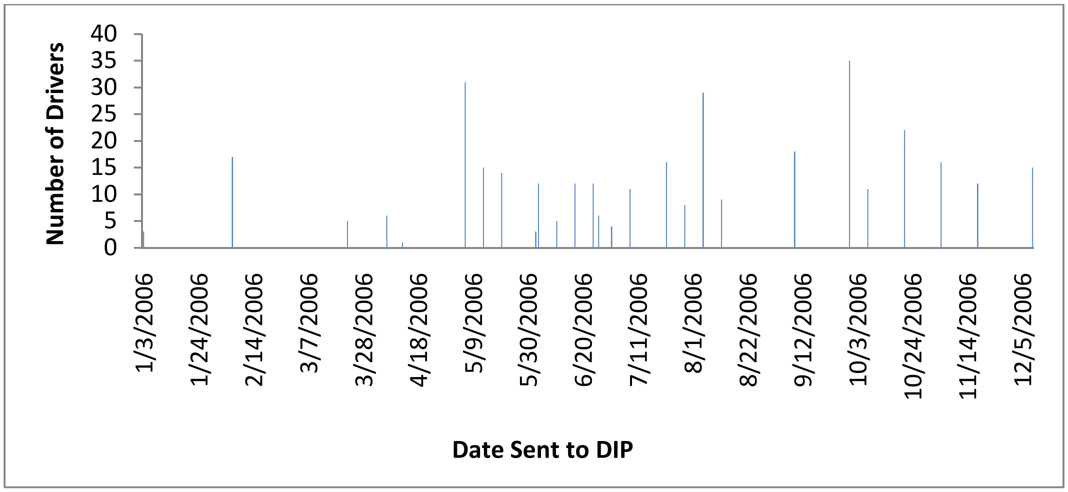
- **Iowa Western Community College, Council Bluffs**

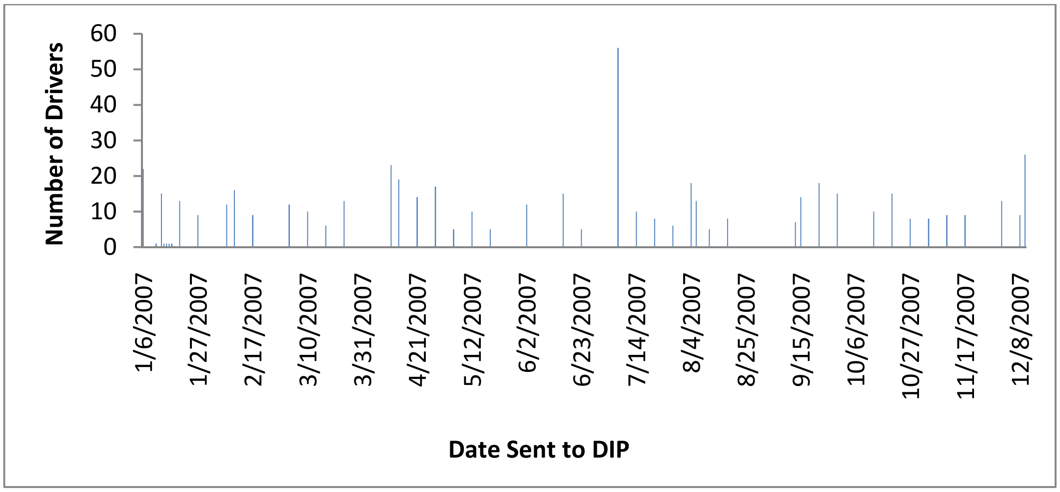


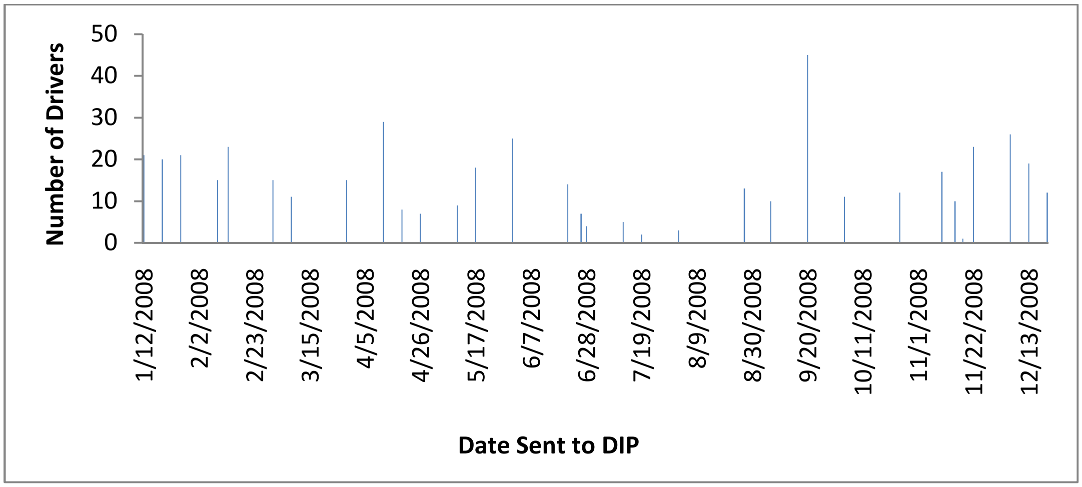




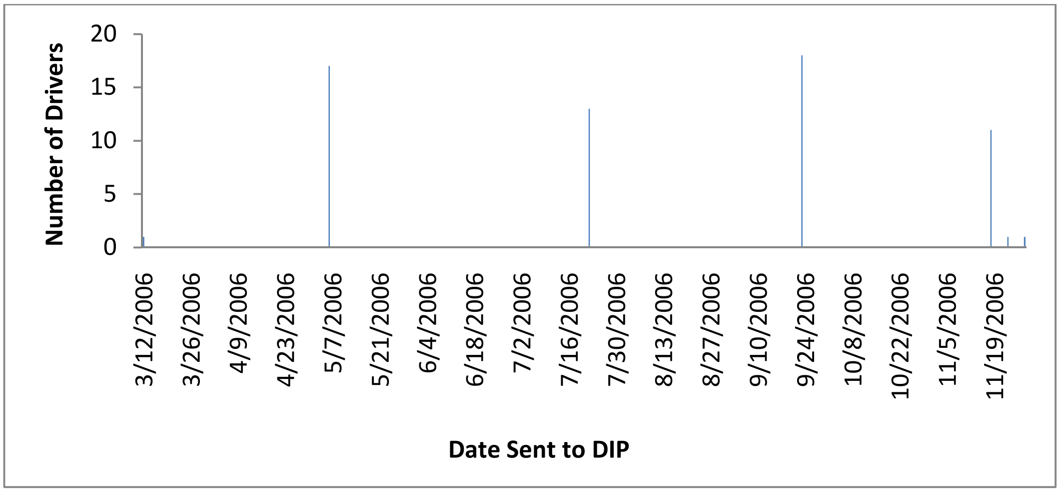
- **Kirkwood Community College, Cedar Rapids**

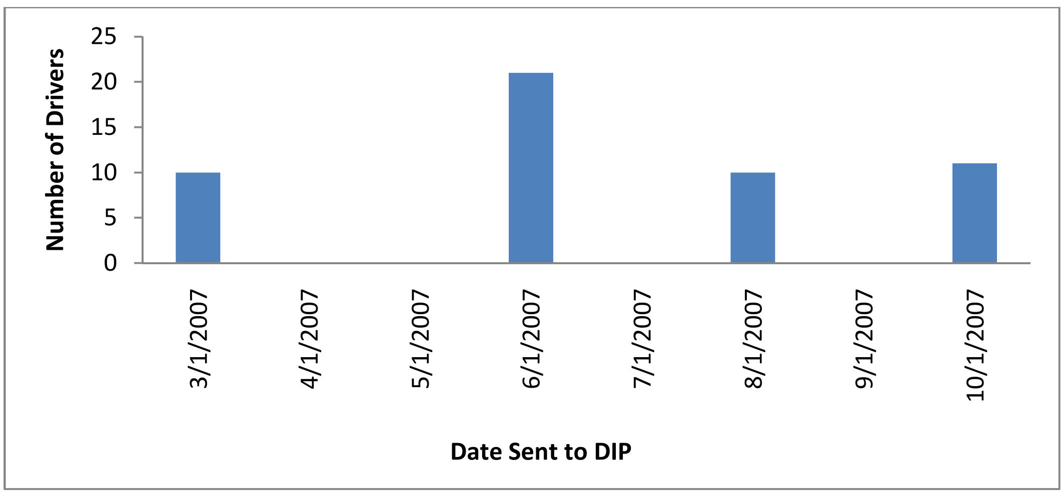


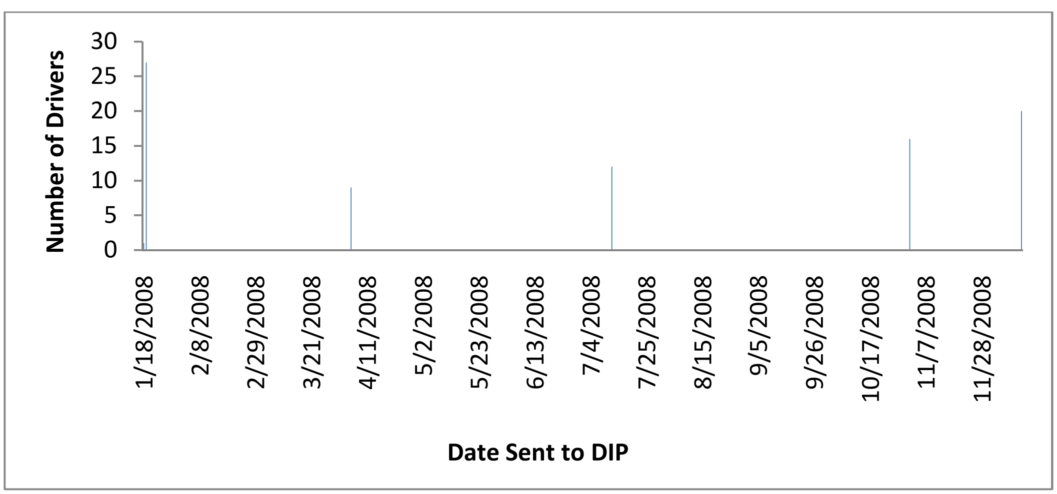




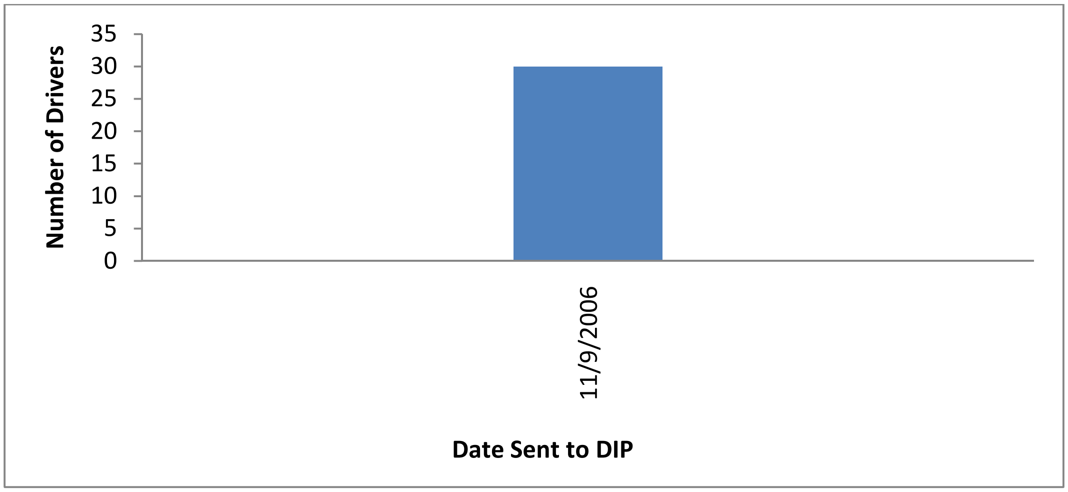
- **Northwest Iowa Community College, Sheldon**

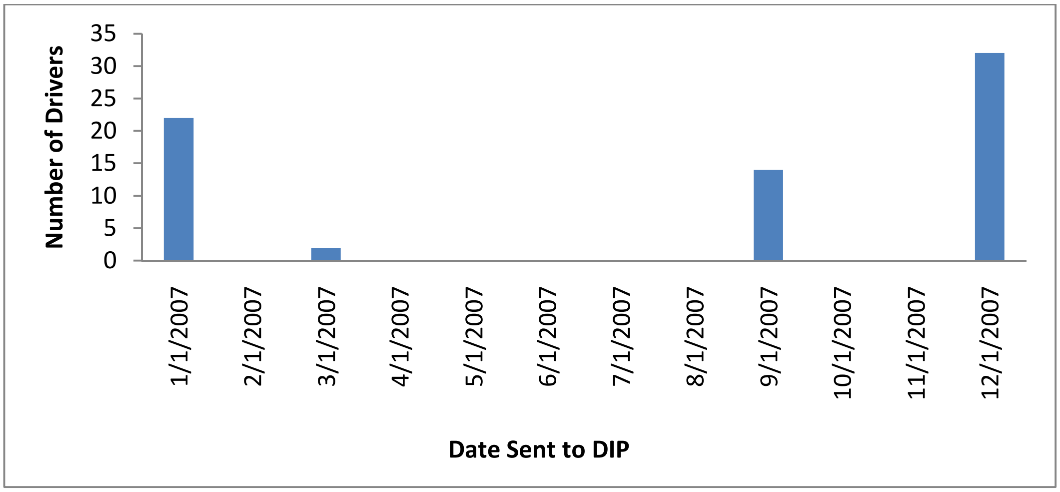


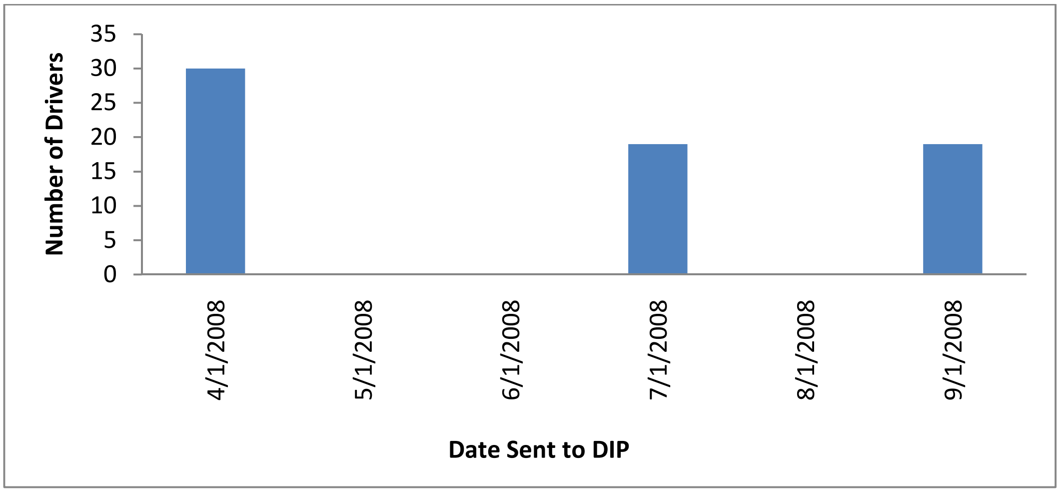




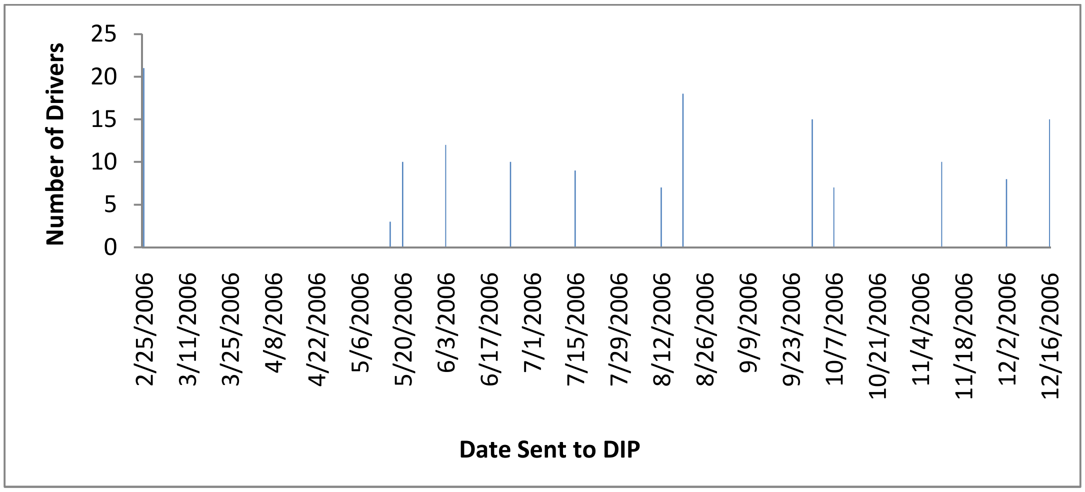
- **North Iowa Area Community College, Mason City**

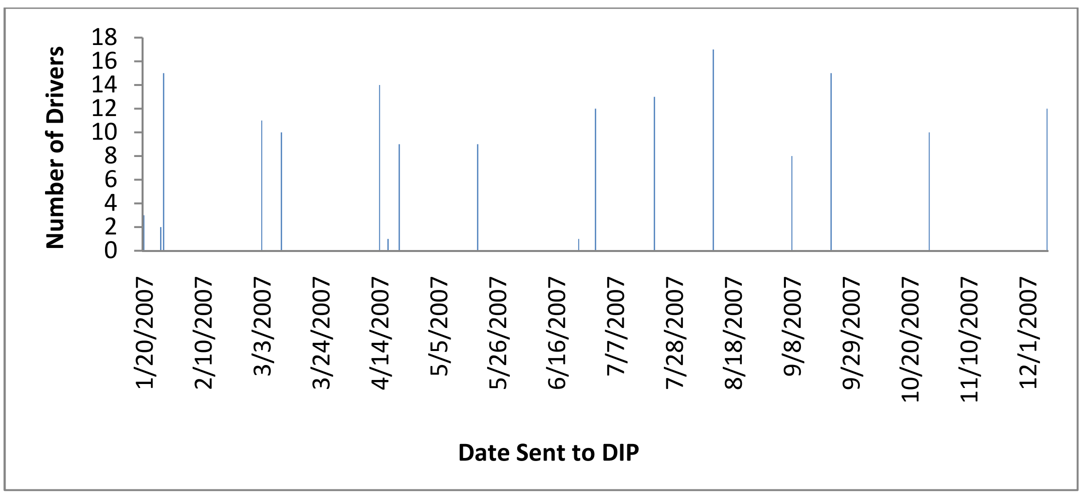


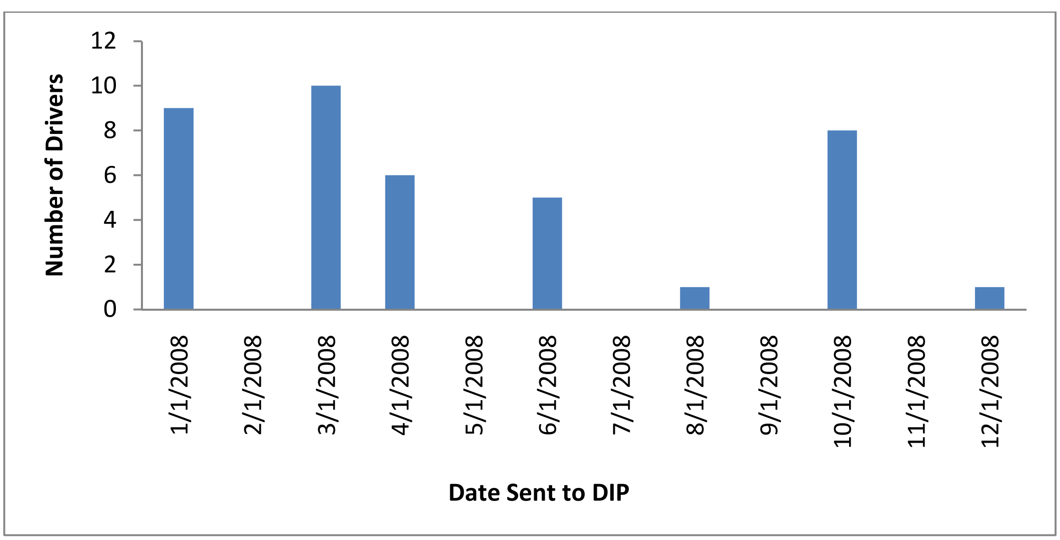




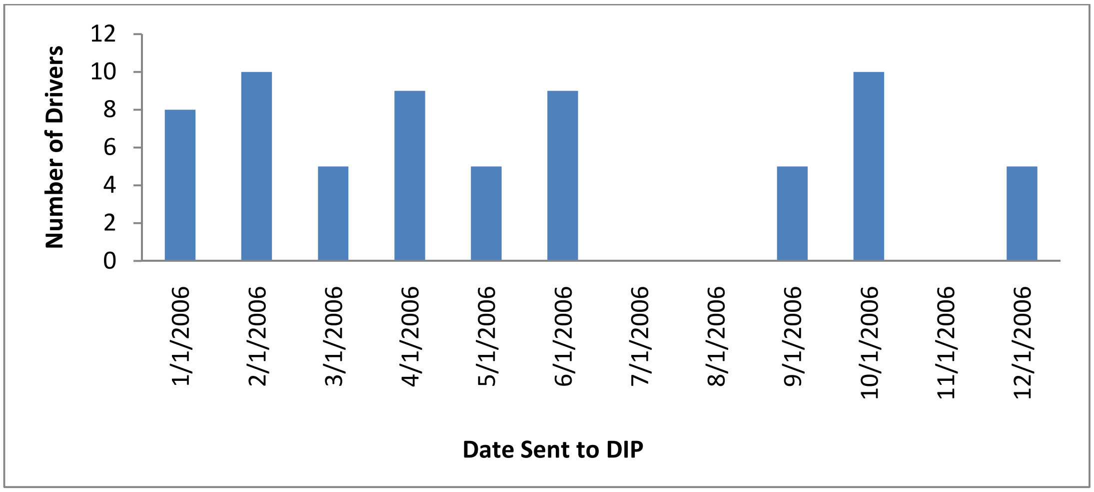
- **Northeast Iowa Community College, Peosta**

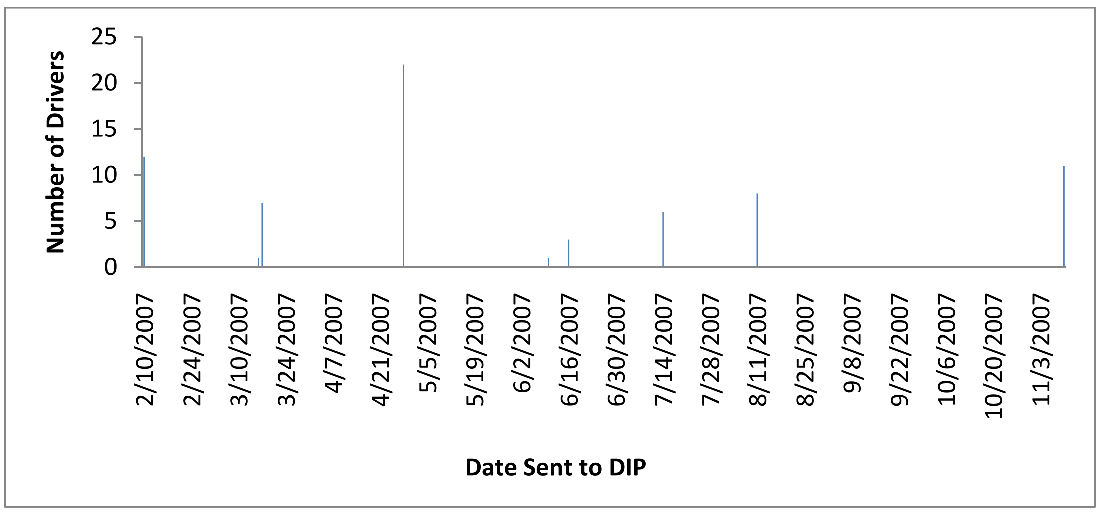


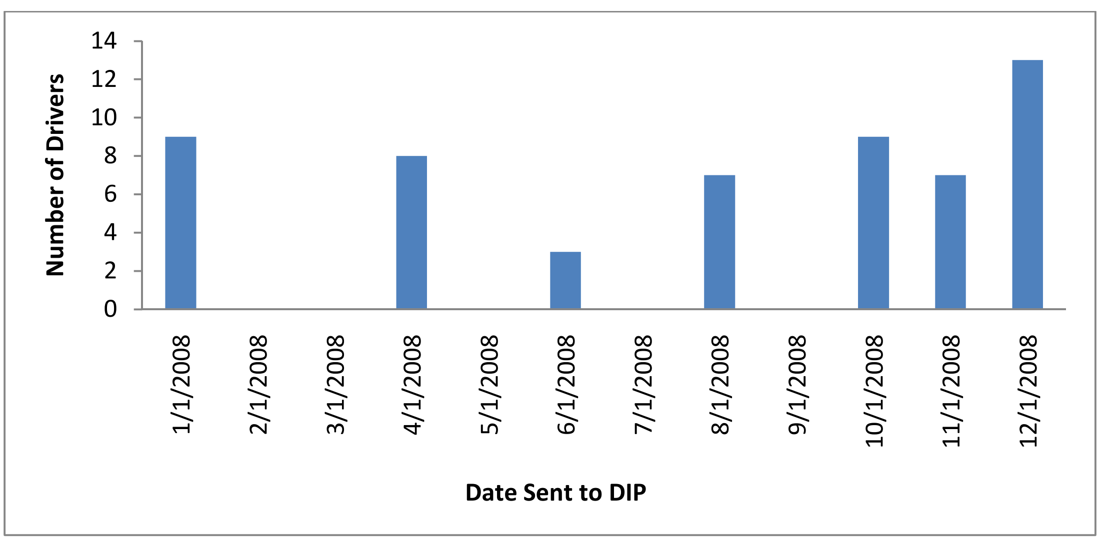




- **Southwestern Community College, Creston**







APPENDIX D. DRIVER CONVICTIONS, CRASHES, AND DIP OUTCOME

Table D.1. Distribution of Driver Convictions and Crashes before and after DIP date

		Before DIP date (by year)				After DIP date(by month)					
		4 years	*3 years*	*2 years*	*1 year*	*1~3*	*4~6*	*7~9*	*10~12*	*13~15*	*16~18*
	Convictions	10693	3851	1645	352	0	0	0	0	177	145
S_0	*Crashes*	878	465	340	105	0	0	0	0	48	18
	Convictions	4545	1589	797	117	534	532	474	386	128	92
S_1	*Crashes*	420	216	161	26	142	138	120	87	25	19
	Convictions	5405	1961	785	151	304	233	202	148	112	77
U	*Crashes*	439	229	165	42	28	30	23	26	23	17

APPENDIX E. MODEL OUTPUTS

E.1.Binary Probit Model Outputs

Binary Probit Model Outputs by Gender

Binary probit model for conviction occurrence after DIP during probation period by gender

Binary Probit Model Outputs- Male

```
--> PROBIT;lhs=PCONV;rhs=one,x8,DMACC,KCC,age5,conv3,conv1,age2cr0,age4cr0$
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Binomial Probit Model                       |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 18, 2010 at 11:05:30AM.|
| Dependent variable                PCONV     |
| Weighting variable                 None     |
| Number of observations             5810     |
| Iterations completed                  5     |
| Log likelihood function       -3127.259     |
| Number of parameters                  9     |
| Info. Criterion: AIC =          1.07961     |
|   Finite Sample: AIC =          1.07961     |
| Info. Criterion: BIC =          1.08994     |
| Info. Criterion:HQIC =          1.08320     |
| Restricted log likelihood     -3180.405     |
| McFadden Pseudo R-squared      .0167103     |
| Chi squared                    106.2909     |
| Degrees of freedom                    8     |
| Prob[ChiSqd > value] =         .0000000     |
| Hosmer-Lemeshow chi-squared =   9.30906     |
| P-value=  .31690 with deg.fr. =       8     |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    -.57630478       .04665799   -12.352   .0000
 X8      |    -.14033904       .04136023    -3.393   .0007    .74991394
 DMACC   |     .12415910       .04027009     3.083   .0020    .33683305
 KCC     |     .11302031       .05343434     2.115   .0344    .14612737
 AGE5    |    -.27546400       .06851592    -4.020   .0001    .10172117
 CONV3   |    -.16021235       .04005523    -4.000   .0001    .32719449
 CONV1   |    -.38546969       .06693547    -5.759   .0000    .10395869
 AGE2CR0 |     .09007330       .04085213     2.205   .0275    .32857143
 AGE4CR0 |    -.14922509       .06342361    -2.353   .0186    .10895009

+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable PCONV      |
+----------------------------------------+
| Proportions P0= .763167   P1= .236833  |
| N =    5810 N0=    4434   N1=    1376  |
| LogL=    -3127.259 LogL0=   -3180.405  |
| Estrella = 1-(L/L0)^(-2L0/n) = .01828  |
```

```
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .01709 |    .01671  |       .64483  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .01744 |    .03438  |       .01813  |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.07961      1.08994   |
+----------------------------------------+
+---------------------------------------------------------+
|Predictions for Binary Choice Model.  Predicted value is |
|1 when probability is greater than  .500000, 0 otherwise.|
|Note, column or row total percentages may not sum to     |
|100% because of rounding. Percentages are of full sample.|
+------+---------------------------------+----------------+
|Actual|         Predicted Value         |                |
|Value |       0                1        | Total Actual   |
+------+----------------+----------------+----------------+
|  0   |   4434 ( 76.3%)|      0 (   .0%)|   4434 ( 76.3%)|
|  1   |   1376 ( 23.7%)|      0 (   .0%)|   1376 ( 23.7%)|
+------+----------------+----------------+----------------+
|Total |   5810 (100.0%)|      0 (   .0%)|   5810 (100.0%)|
+------+----------------+----------------+----------------+

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                      .000%
Specificity = actual 0s correctly predicted                    100.000%
Positive predictive value = predicted 1s that were actual 1s      .000%
Negative predictive value = predicted 0s that were actual 0s    76.317%
Correct prediction = actual 1s and 0s correctly predicted       76.317%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s             .000%
False neg. for true pos. = actual 1s predicted as 0s           100.000%
False pos. for predicted pos. = predicted 1s actual 0s           .000%
False neg. for predicted neg. = predicted 0s actual 1s          23.683%
False predictions = actual 1s and 0s incorrectly predicted      23.683%
```

Binary Probit Model Outputs- Female

```
--> PROBIT;lhs=PCONV;rhs=one,conv1,conv3,conv4,x8,crash0,age2cr0$
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Binomial Probit Model                       |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 18, 2010 at 11:06:46AM.|
| Dependent variable               PCONV      |
| Weighting variable                None      |
| Number of observations            3245      |
| Iterations completed                 5      |
| Log likelihood function      -1669.944      |
| Number of parameters                 7      |
```

```
| Info. Criterion: AIC =          1.03356     |
|   Finite Sample: AIC =          1.03357     |
| Info. Criterion: BIC =          1.04668     |
| Info. Criterion:HQIC =          1.03826     |
| Restricted log likelihood     -1697.198     |
| McFadden Pseudo R-squared      .0160580     |
| Chi squared                    54.50735     |
| Degrees of freedom                    6     |
| Prob[ChiSqd > value] =         .0000000     |
| Hosmer-Lemeshow chi-squared =   8.68921     |
| P-value=  .36919 with deg.fr. =       8     |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    -.42839891       .06760114    -6.337   .0000
 CONV1   |    -.42832939       .08987158    -4.766   .0000    .12141757
 CONV3   |    -.24768721       .06084361    -4.071   .0000    .33651772
 CONV4   |    -.17850557       .06662401    -2.679   .0074    .23266564
 X8      |    -.14527875       .05619951    -2.585   .0097    .74976888
 CRASH0  |    -.20926675       .06206076    -3.372   .0007    .67241911
 AGE2CR0 |     .17239091       .06176658     2.791   .0053    .34083205

+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable PCONV      |
+----------------------------------------+
| Proportions P0= .783051   P1= .216949  |
| N =    3245 N0=    2541   N1=     704  |
| LogL=    -1669.944 LogL0=   -1697.198  |
| Estrella = 1-(L/L0)^(-2L0/n) = .01679  |
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .01602 |    .01606  |        .66582 |
|    Cramer | Veall/Zim. |      Rsqrd_ML |
|    .01637 |    .03231  |        .01666 |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.03356       1.04668  |
+----------------------------------------+
+---------------------------------------------------------+
|Predictions for Binary Choice Model.  Predicted value is |
|1 when probability is greater than  .500000, 0 otherwise.|
|Note, column or row total percentages may not sum to     |
|100% because of rounding. Percentages are of full sample.|
+------+---------------------------------+----------------+
|Actual|         Predicted Value         |                |
|Value |       0                1        | Total Actual   |
+------+----------------+----------------+----------------+
|  0   |   2541 ( 78.3%)|      0 (   .0%)|   2541 ( 78.3%)|
|  1   |    704 ( 21.7%)|      0 (   .0%)|    704 ( 21.7%)|
+------+----------------+----------------+----------------+
|Total |   3245 (100.0%)|      0 (   .0%)|   3245 (100.0%)|
+------+----------------+----------------+----------------+

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                       .000%
Specificity = actual 0s correctly predicted                    100.000%
```

```
Positive predictive value = predicted 1s that were actual 1s      .000%
Negative predictive value = predicted 0s that were actual 0s    78.305%
Correct prediction = actual 1s and 0s correctly predicted       78.305%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s              .000%
False neg. for true pos. = actual 1s predicted as 0s           100.000%
False pos. for predicted pos. = predicted 1s actual 0s            .000%
False neg. for predicted neg. = predicted 0s actual 1s          21.695%
False predictions = actual 1s and 0s incorrectly predicted      21.695%
=======================================================================
```

Binary Probit Model Outputs by Age

Binary Probit Model Outputs- Age group one: 30 years old or younger

```
PROBIT;lhs=PCONV;rhs=one,conv1,x8,sco4,conv3,malcr0$
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Binomial Probit Model                       |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 17, 2010 at 03:14:22PM.|
| Dependent variable               PCONV      |
| Weighting variable                None      |
| Number of observations            5199      |
| Iterations completed                 5      |
| Log likelihood function      -2927.357      |
| Number of parameters                 6      |
| Info. Criterion: AIC =         1.12843      |
|   Finite Sample: AIC =         1.12843      |
| Info. Criterion: BIC =         1.13600      |
| Info. Criterion:HQIC =         1.13108      |
| Restricted log likelihood    -2955.278      |
| McFadden Pseudo R-squared     .0094478      |
| Chi squared                   55.84199      |
| Degrees of freedom                   5      |
| Prob[ChiSqd > value] =        .0000000      |
| Hosmer-Lemeshow chi-squared =  4.94169      |
| P-value=  .76379 with deg.fr. =      8      |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    -.49551792       .04254211   -11.648   .0000
 CONV1   |    -.40566226       .06976442    -5.815   .0000    .10636661
 X8      |    -.09941631       .04417159    -2.251   .0244    .73110214
 SCO4    |    -.14944370       .05760447    -2.594   .0095    .16887863
 CONV3   |    -.18047133       .04453835    -4.052   .0001    .32871706
 MALCR0  |     .07766702       .03832174     2.027   .0427    .41469513

+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable PCONV      |
+----------------------------------------+
| Proportions P0= .744374   P1= .255626  |
| N =    5199 N0=    3870   N1=    1329  |
| LogL=    -2927.357 LogL0=   -2955.278  |
| Estrella = 1-(L/L0)^(-2L0/n) = .01073  |
```

```
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .01050 |    .00945  |       .62345  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .01054 |    .01997  |       .01068  |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.12843      1.13600   |
+----------------------------------------+
+--------------------------------------------------------+
|Predictions for Binary Choice Model.  Predicted value is |
|1 when probability is greater than  .500000, 0 otherwise.|
|Note, column or row total percentages may not sum to     |
|100% because of rounding. Percentages are of full sample.|
+------+---------------------------------+----------------+
|Actual|         Predicted Value         |                |
|Value |       0                1        | Total Actual   |
+------+----------------+----------------+----------------+
|  0   |   3870 ( 74.4%)|      0 (   .0%)|   3870 ( 74.4%)|
|  1   |   1329 ( 25.6%)|      0 (   .0%)|   1329 ( 25.6%)|
+------+----------------+----------------+----------------+
|Total |   5199 (100.0%)|      0 (   .0%)|   5199 (100.0%)|
+------+----------------+----------------+----------------+

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                        .000%
Specificity = actual 0s correctly predicted                     100.000%
Positive predictive value = predicted 1s that were actual 1s       .000%
Negative predictive value = predicted 0s that were actual 0s     74.437%
Correct prediction = actual 1s and 0s correctly predicted         74.437%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s               .000%
False neg. for true pos. = actual 1s predicted as 0s            100.000%
False pos. for predicted pos. = predicted 1s actual 0s             .000%
False neg. for predicted neg. = predicted 0s actual 1s           25.563%
False predictions = actual 1s and 0s incorrectly predicted        25.563%
=======================================================================
```

Binary Probit Model Outputs- Age group two: 31 to 40 years old

```
--> PROBIT;lhs=PCONV;rhs=one,conv1,conv3,lo1S,x8$
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Binomial Probit Model                       |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 17, 2010 at 03:19:51PM.|
| Dependent variable               PCONV      |
| Weighting variable                None      |
| Number of observations            1775      |
| Iterations completed                 5      |
| Log likelihood function      -885.8241      |
| Number of parameters                 5      |
| Info. Criterion: AIC =         1.00375      |
|   Finite Sample: AIC =         1.00376      |
| Info. Criterion: BIC =         1.01919      |
```

```
| Info. Criterion:HQIC =          1.00945      |
| Restricted log likelihood     -900.5492      |
| McFadden Pseudo R-squared      .0163513      |
| Chi squared                    29.45032      |
| Degrees of freedom                    4      |
| Prob[ChiSqd > value] =         .6331330E-05 |
| Hosmer-Lemeshow chi-squared =   4.13027      |
| P-value=  .84518 with deg.fr. =       8      |
+----------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    -.59218603       .06952141    -8.518   .0000
 CONV1   |    -.44713625       .12712804    -3.517   .0004    .10309859
 CONV3   |    -.24315578       .07482095    -3.250   .0012    .33690141
 LO1S    |     .20690049       .08352410     2.477   .0132    .24901408
 X8      |    -.23153124       .08124670    -2.850   .0044    .73352113

+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable PCONV      |
+----------------------------------------+
| Proportions P0= .794930   P1= .205070  |
| N =    1775 N0=    1411   N1=     364  |
| LogL=     -885.824 LogL0=    -900.549  |
| Estrella = 1-(L/L0)^(-2L0/n) = .01659  |
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .01571 |     .01635 |        .67919  |
|    Cramer | Veall/Zim. |      Rsqrd_ML  |
|    .01599 |     .03241 |        .01645  |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.00375      1.01919   |
+----------------------------------------+
+---------------------------------------------------------+
|Predictions for Binary Choice Model.  Predicted value is |
|1 when probability is greater than  .500000, 0 otherwise.|
|Note, column or row total percentages may not sum to     |
|100% because of rounding. Percentages are of full sample.|
+------+---------------------------------+----------------+
|Actual|         Predicted Value         |                |
|Value |       0                1        | Total Actual   |
+------+----------------+----------------+----------------+
|  0   |   1411 ( 79.5%)|      0 (   .0%)|   1411 ( 79.5%)|
|  1   |    364 ( 20.5%)|      0 (   .0%)|    364 ( 20.5%)|
+------+----------------+----------------+----------------+
|Total |   1775 (100.0%)|      0 (   .0%)|   1775 (100.0%)|
+------+----------------+----------------+----------------+

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                        .000%
Specificity = actual 0s correctly predicted                     100.000%
Positive predictive value = predicted 1s that were actual 1s      .000%
Negative predictive value = predicted 0s that were actual 0s    79.493%
Correct prediction = actual 1s and 0s correctly predicted       79.493%
-----------------------------------------------------------------------
Prediction Failure
```

```
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s              .000%
False neg. for true pos. = actual 1s predicted as 0s           100.000%
False pos. for predicted pos. = predicted 1s actual 0s            .000%
False neg. for predicted neg. = predicted 0s actual 1s          20.507%
False predictions = actual 1s and 0s incorrectly predicted      20.507%
=======================================================================
```

Binary Probit Model Outputs- Age group three: 40 years old or older

```
--> PROBIT;lhs=PCONV;rhs=one,x8,lo1s,conv1,conv3$
Normal exit from iterations. Exit status=0.

+---------------------------------------------+
| Binomial Probit Model                       |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 17, 2010 at 03:36:52PM.|
| Dependent variable               PCONV      |
| Weighting variable                None      |
| Number of observations            2081      |
| Iterations completed                 5      |
| Log likelihood function      -982.0724      |
| Number of parameters                 5      |
| Info. Criterion: AIC =          .94865      |
|   Finite Sample: AIC =          .94867      |
| Info. Criterion: BIC =          .96220      |
| Info. Criterion:HQIC =          .95362      |
| Restricted log likelihood    -999.5539      |
| McFadden Pseudo R-squared      .0174893     |
| Chi squared                    34.96297     |
| Degrees of freedom                   4      |
| Prob[ChiSqd > value] =         .0000000     |
| Hosmer-Lemeshow chi-squared =  13.54016     |
| P-value=  .09457 with deg.fr. =      8      |
+---------------------------------------------+
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
---------+Index function for probability
 Constant|    -.64028123       .07523475    -8.510   .0000
 X8      |    -.27339748       .08387613    -3.260   .0011    .81066795
 LO1S    |     .25377001       .07462889     3.400   .0007    .27534839
 CONV1   |    -.42532564       .11080815    -3.838   .0001    .12590101
 CONV3   |    -.19409700       .07098280    -2.734   .0062    .32964921

+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable PCONV      |
+----------------------------------------+
| Proportions P0= .814032   P1= .185968  |
| N =    2081 N0=    1694   N1=     387  |
| LogL=     -982.072 LogL0=    -999.554  |
| Estrella = 1-(L/L0)^(-2L0/n) = .01681  |
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .01676 |    .01749  |       .70224  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .01657 |    .03372  |       .01666  |
+----------------------------------------+
```

```
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        .94865       .96220  |
+----------------------------------------+
+---------------------------------------------------------+
|Predictions for Binary Choice Model.  Predicted value is |
|1 when probability is greater than  .500000, 0 otherwise.|
|Note, column or row total percentages may not sum to      |
|100% because of rounding. Percentages are of full sample.|
+------+---------------------------------+----------------+
|Actual|         Predicted Value          |                |
|Value |       0                1         | Total Actual   |
+------+----------------+----------------+----------------+
|  0   |   1694 ( 81.4%)|      0 (   .0%)|   1694 ( 81.4%)|
|  1   |    387 ( 18.6%)|      0 (   .0%)|    387 ( 18.6%)|
+------+----------------+----------------+----------------+
|Total |   2081 (100.0%)|      0 (   .0%)|   2081 (100.0%)|
+------+----------------+----------------+----------------+

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                       .000%
Specificity = actual 0s correctly predicted                    100.000%
Positive predictive value = predicted 1s that were actual 1s      .000%
Negative predictive value = predicted 0s that were actual 0s    81.403%
Correct prediction = actual 1s and 0s correctly predicted       81.403%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s              .000%
False neg. for true pos. = actual 1s predicted as 0s           100.000%
False pos. for predicted pos. = predicted 1s actual 0s            .000%
False neg. for predicted neg. = predicted 0s actual 1s          18.597%
False predictions = actual 1s and 0s incorrectly predicted      18.597%
=======================================================================
```

E.2 Negative Binomial Model Outputs

Negative Binomial Model Outputs by Gender

Negative Binomial Model Outputs-Male

```
Frequency of Convictions after DIP during probation period by gender
Male

--> negbin;lhs=x9;rhs=one,age5,conv1,conv3,x8,age2lo1,age3,age2co4,age4$
+---------------------------------------------+
| Negative Binomial Regression                |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 17, 2010 at 05:19:44PM.|
| Dependent variable                 X9       |
| Weighting variable               None       |
| Number of observations           5810       |
| Iterations completed               14       |
| Log likelihood function       -4184.177     |
| Number of parameters               11       |
| Info. Criterion: AIC =          1.44412     |
```

```
|   Finite Sample: AIC =          1.44413     |
| Info. Criterion: BIC =          1.45675     |
| Info. Criterion:HQIC =          1.44851     |
| Restricted log likelihood     -4298.424     |
| McFadden Pseudo R-squared      .0265789     |
| Chi squared                    228.4949     |
| Degrees of freedom                    1     |
| Prob[ChiSqd > value] =         .0000000     |
| NegBin form 2; Psi(i) = theta               |
+---------------------------------------------+
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
 Constant|    -.55453252       .06969963    -7.956   .0000
 AGE5    |    -.73389664       .11776742    -6.232   .0000    .10172117
 CONV1   |    -.61285152       .10317921    -5.940   .0000    .10395869
 CONV3   |    -.29555961       .06331456    -4.668   .0000    .32719449
 X8      |    -.38416152       .06717266    -5.719   .0000    .74991394
 AGE2LO1 |    -.18491142       .09376579    -1.972   .0486    .16574871
 AGE3    |    -.38591889       .08110402    -4.758   .0000    .19414802
 AGE2CO4 |    -.23712718       .09047477    -2.621   .0088    .12151463
 AGE4    |    -.41830015       .09083412    -4.605   .0000    .13803787
 LO1S    |     .31786433       .08334654     3.814   .0001    .25318417
---------+Dispersion parameter for count data model
 Alpha   |    1.07105177       .10433729    10.265   .0000
```

Negative Binomial Model Outputs-Female

```
--> negbin;lhs=x9;rhs=one,conv1,x8,conv3,age3s$
+---------------------------------------------+
| Negative Binomial Regression                |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 17, 2010 at 05:45:26PM.|
| Dependent variable                    X9    |
| Weighting variable                  None    |
| Number of observations              3245    |
| Iterations completed                   8    |
| Log likelihood function        -2214.243    |
| Number of parameters                   6    |
| Info. Criterion: AIC =           1.36841    |
|   Finite Sample: AIC =           1.36842    |
| Info. Criterion: BIC =           1.37966    |
| Info. Criterion:HQIC =           1.37244    |
| Restricted log likelihood      -2292.634    |
| McFadden Pseudo R-squared       .0341924    |
| Chi squared                     156.7814    |
| Degrees of freedom                     1    |
| Prob[ChiSqd > value] =          .0000000    |
| NegBin form 2; Psi(i) = theta               |
+---------------------------------------------+
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
 Constant|    -.84839105       .07046574   -12.040   .0000
 CONV1   |    -.66539233       .14535308    -4.578   .0000    .12141757
 X8      |    -.27909676       .08604445    -3.244   .0012    .74976888
 CONV3   |    -.26749430       .08551440    -3.128   .0018    .33651772
 AGE3S   |    -.26022084       .12039668    -2.161   .0307    .14730354
---------+Dispersion parameter for count data model
 Alpha   |    1.32102859       .15814820     8.353   .0000
```

Negative Binomial Model Outputs by Age

Negative Binomial Model Outputs-Age group one: 30 years old or younger

```
--> negbin;lhs=x9;rhs=one,conv1,conv3,maleu,sco4 $
+---------------------------------------------+
| Negative Binomial Regression                |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 18, 2010 at 10:41:28AM.|
| Dependent variable                 X9       |
| Weighting variable               None       |
| Number of observations           5199       |
| Iterations completed                9       |
| Log likelihood function     -4008.668       |
| Number of parameters                6       |
| Info. Criterion: AIC =        1.54440       |
|   Finite Sample: AIC =        1.54440       |
| Info. Criterion: BIC =        1.55197       |
| Info. Criterion:HQIC =        1.54705       |
| Restricted log likelihood   -4126.587       |
| McFadden Pseudo R-squared    .0285755       |
| Chi squared                  235.8383       |
| Degrees of freedom                  1       |
| Prob[ChiSqd > value] =       .0000000       |
| NegBin form 2; Psi(i) = theta               |
+---------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
 Constant|    -.91291210       .04626835   -19.731   .0000
 CONV1   |    -.59158741       .10404629    -5.686   .0000    .10636661
 CONV3   |    -.26820651       .06532282    -4.106   .0000    .32871706
 MALEU   |     .22825506       .07136754     3.198   .0014    .17157146
 SCO4    |    -.22637983       .08185737    -2.766   .0057    .16887863
---------+Dispersion parameter for count data model
 Alpha   |    1.08769021       .10729194    10.138   .0000
```

Negative Binomial Model Outputs-Age group two: 31 to 40 years old

```
--> negbin;lhs=x9;rhs=one,conv1,conv3,lo1S,x8$
+---------------------------------------------+
| Negative Binomial Regression                |
| Maximum Likelihood Estimates                |
| Model estimated: Mar 18, 2010 at 10:35:58AM.|
| Dependent variable                 X9       |
| Weighting variable               None       |
| Number of observations           1775       |
| Iterations completed                8       |
| Log likelihood function     -1162.906       |
| Number of parameters                6       |
| Info. Criterion: AIC =        1.31708       |
|   Finite Sample: AIC =        1.31710       |
| Info. Criterion: BIC =        1.33561       |
| Info. Criterion:HQIC =        1.32392       |
| Restricted log likelihood   -1208.856       |
| McFadden Pseudo R-squared    .0380109       |
| Chi squared                  91.89934       |
| Degrees of freedom                  1       |
| Prob[ChiSqd > value] =       .0000000       |
| NegBin form 2; Psi(i) = theta               |
+---------------------------------------------+
```

```
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
 Constant|    -.84210142       .09079538    -9.275   .0000
 CONV1   |    -.69110846       .20444104    -3.380   .0007    .10309859
 CONV3   |    -.36094615       .12126335    -2.977   .0029    .33690141
 LO1S    |     .33334955       .14305555     2.330   .0198    .24901408
 X8      |    -.52539271       .12558052    -4.184   .0000    .73352113
---------+Dispersion parameter for count data model
 Alpha   |    1.43061815       .22356063     6.399   .0000
```

Negative Binomial Model Outputs-Age group three: 41 years old or older

```
--> negbin;lhs=x9;rhs=one,conv1,x8,crash1,lo1s,conv3$
+---------------------------------------------+
| Negative Binomial Regression                 |
| Maximum Likelihood Estimates                 |
| Model estimated: Mar 18, 2010 at 10:45:19AM.|
| Dependent variable                  X9       |
| Weighting variable                None       |
| Number of observations            2081       |
| Iterations completed                 9       |
| Log likelihood function      -1218.551       |
| Number of parameters                 7       |
| Info. Criterion: AIC =         1.17785       |
|   Finite Sample: AIC =         1.17787       |
| Info. Criterion: BIC =         1.19682       |
| Info. Criterion:HQIC =         1.18480       |
| Restricted log likelihood    -1245.028       |
| McFadden Pseudo R-squared     .0212661       |
| Chi squared                   52.95386       |
| Degrees of freedom                   1       |
| Prob[ChiSqd > value] =        .0000000       |
| NegBin form 2; Psi(i) = theta                |
+---------------------------------------------+
+--------+-------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+-------------+----------------+--------+--------+----------+
 Constant|   -1.11147532       .10788279   -10.303   .0000
 CONV1   |    -.73152052       .20224645    -3.617   .0003    .12590101
 X8      |    -.52560259       .12626178    -4.163   .0000    .81066795
 CRASH1  |     .36504327       .11623784     3.140   .0017    .20230658
 LO1S    |     .45726863       .12008546     3.808   .0001    .27534839
 CONV3   |    -.28941028       .11140688    -2.598   .0094    .32964921
---------+Dispersion parameter for count data model
 Alpha   |    1.06049691       .19429058     5.458   .0000
```

APPENDIX F. ASSOCIATIOIN RULES OUTPUT

Table F.1 Lift value for female drivers

Female Driver (Population: 3,245)			
Cause Factor	Lift	Confidence	support
Drivers 30 years of age or younger	1.10	7%	4.0%
Drivers between 31 and 40 years of age	0.82	5%	1.0%
Drivers 41 years of age or older	0.89	6%	1.2%
Unsatisfactory	0.68	4%	1.0%
Satisfactory	1.11	7%	5.1%
One Conviction before DIP	0.94	6%	0.7%
Two Convictions before DIP	0.83	5%	0.4%
Three Convictions before DIP	1.06	7%	2.2%
Four Convictions before DIP	1.01	6%	1.4%
Five Convictions before DIP	0.85	5%	0.7%
Six Convictions before DIP	1.35	8%	0.4%
Seven Convictions before DIP	1.19	7%	0.2%
Eight Convictions before DIP	1.15	7%	0.1%
One Crash before DIP	1.24	8%	2.0%
Two Crashes before DIP	0.97	6%	0.3%
Three Crashes before DIP	2.07	13%	0.2%
Four Convictions or more before DIP	1.01	6%	2.8%

Table F.2 Lift value for male drivers

Male Driver (Population: 5,810)			
Cause Factor	Lift	Confidence	support
Drivers 30 years of age or younger	1.14	7%	3.7%
Drivers between 31 and 40 years of age	0.92	5%	1.0%
Drivers 41 years of age or older	0.77	4%	1.1%
Unsatisfactory	0.75	4%	1.1%
Satisfactory	1.08	6%	4.7%
One Conviction before DIP	0.72	4%	0.4%
Two Convictions before DIP	0.94	5%	0.5%
Three Convictions before DIP	0.96	6%	1.8%
Four Convictions before DIP	0.98	6%	1.3%
Five Convictions before DIP	1.37	8%	1.0%
Six Convictions before DIP	1.06	6%	0.4%
Seven Convictions before DIP	1.54	9%	0.2%

Eight Convictions before DIP	0.26	2%	0.0%
One Crash before DIP	1.06	6%	1.4%
Two Crashes before DIP	1.29	7%	0.4%
Three Crashes before DIP	1.81	10%	0.1%
Four Convictions or more before DIP	1.11	6%	3.0%
One to three Convictions before DIP	0.91	5%	2.8%

Table F.3 Lift value for drivers 30 years of age or younger

Drivers 30 years of age or younger (Population: 5,199)			
Cause Factor	Lift	Confidence	support
Female	1.03	7%	2.5%
Male	0.98	6%	4.1%
Unsatisfactory	0.66	4%	1.2%
Satisfactory	1.12	7%	5.4%
One Conviction before DIP	0.82	5%	0.6%
Two Convictions before DIP	1.03	7%	0.6%
Three Convictions before DIP	1.09	7%	2.4%
Four Convictions before DIP	0.88	6%	1.3%
Five Convictions before DIP	1.08	7%	1.0%
Six Convictions before DIP	1.10	7%	0.4%
Seven Convictions before DIP	1.26	8%	0.2%
Eight Convictions before DIP	0.53	4%	0.0%
One Crash before DIP	1.00	7%	1.8%
Two Crashes before DIP	1.04	7%	0.4%
Three Crashes before DIP	1.62	11%	0.1%
Four Convictions or more before DIP	0.98	6%	3.0%
One to three Convictions before DIP	1.03	7%	3.6%

Table F.4 Lift value for drivers between 31 and 40 years of age

Drivers between 31 and 40 years of age (Population: 1,775)			
	Lift	Confidence	support
Female	0.97	5%	1.9%
male	1.02	5%	3.4%
Outcome (u)	1.05	5%	1.5%
Outcome (s)	0.98	5%	3.8%
One Conviction before DIP	0.83	4%	0.5%
Two Convictions before DIP	0.90	5%	0.4%

Three Convictions before DIP	0.51	3%	0.9%
Four Convictions before DIP	1.29	7%	1.6%
Five Convictions before DIP	1.82	10%	1.2%
Six Convictions before DIP	1.10	6%	0.4%
Seven Convictions before DIP	2.03	11%	0.3%
Eight Convictions before DIP	0.00	0%	0.0%
One Crash before DIP	1.51	8%	1.6%
Two Crashes before DIP	0.99	5%	0.2%
Three Crashes before DIP	4.40	23%	0.2%
Four Convictions or more before DIP	1.42	7%	3.5%
One to three Convictions before DIP	0.64	3%	1.7%

Table F.5 Lift value for drivers 41 years of age or older

Drivers 41 years of age or older (Population: 2,081)			
	Lift	Confidence	support
Female	1.15	6%	1.8%
male	0.93	4%	3.0%
Outcome (u)	0.53	3%	0.5%
Outcome (s)	1.11	5%	4.3%
One Conviction before DIP	0.79	4%	0.5%
Two Convictions before DIP	0.51	2%	0.2%
Three Convictions before DIP	1.15	6%	1.8%
Four Convictions before DIP	1.06	5%	1.2%
Five Convictions before DIP	0.85	4%	0.5%
Six Convictions before DIP	1.41	7%	0.4%
Seven Convictions before DIP	1.41	7%	0.2%
Eight Convictions before DIP	1.16	6%	0.0%
One Crash before DIP	1.29	6%	1.2%
Two Crashes before DIP	1.84	9%	0.3%
Three Crashes before DIP	1.16	6%	0.0%
Four Convictions or more before DIP	1.07	5%	2.3%
One to three Convictions before DIP	0.96	4%	2.5%

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