Reassessing Road Sign Test of Drivers in Bangladesh

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A THESIS SUBMITTED

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

ISLAMIC UNIVERSITY OF TECHNOLOGY

NOVEMBER, 2015

RECOMMENDATION OF THR BOARD OF EXAMINERS

The thesis titled “Reassessing Road Sign Test of Drivers in Bangladesh” submitted by Mahadi Hasan Rifat, St. No. 115415 & Md. Ahsanul Abedin, St. No. 115422 of Academic Year 2011-15 has been found as satisfactory and accepted as partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering.

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DECLARATION OF CANDIDATE

We hereby declare that, undergraduate project work reported in this thesis has been performed by us and this has not been submitted elsewhere for any purpose except for publication.

November 2015

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Dedication

DEDICATED TO OUR
BELOVED PARENTS

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ACKNOWLEDGEMENTS

"In the name of Allah, Most Gracious, Most Merciful"

All praises belong to the almighty Allah for giving us the strength and courage to successfully complete our B.Sc. thesis.

We would like to express our sincere appreciation to our supervisor Dr. Shakil Mohammad Rifaat; Associate Professor of the Department of Civil and Environmental Engineering, Islamic University of Technology (IUT), for his generous guidance, advice and encouragement in supervising us. His technical and editorial advice was essential for the completion of this academic research. Without his assistance and guidance the paper would never been accomplished.

Our gratitude also goes to all the faculty members for their thoughtful recommendations during our study.

Finally, we would like to thank our beloved parents, for their never ending encouragement and supports.

Abstract

Road crashes are one of the vital causes of death and heavy injuries around the world. Every year a lot of people died due to road crashes. In developing countries like Bangladesh, the crashing incidence is too high. Drivers' fault is one of the main reason for the road crashes. If the drivers are properly trained, if they follow the road signs and traffic laws accordingly and if they are responsible enough while driving, road crashes and injuries can be minimized significantly and this will help to improve road safety scenarios. This study helps to identify those groups of driver who are not physically fit enough to drive, who have not trained properly, who are not capable of recalling necessary road signs and traffic laws after some years of their driving. This study reveals those groups of driver through a road sign test. Drivers' who scored poorly in comparison with other drivers is the targeted groups of driver who requires safety education. A questionnaire survey was conducted among bus drivers, car drivers and truck drivers and a total of 300 samples were collected. A linear regression model analysis was applied to analyze the data. Result shows that test score of the drivers varied significantly with their age, education level, frequency of driving, experiences, effects of drug and alcohol etc. From the model result, the drivers who need further training can be identified easily. If any road safety training is introduced, then this selected groups of driver should get the priority first. It would be a better idea to train all the drivers after some years of their driving. But in country like Bangladesh it would not be economically feasible. So this study helps to identify those targeted groups of driver, who need to facilitate with further training.

Chapter 1

Introduction

1.1 Background

Road crashes are one of the main causes of death and heavy injury around the world. Around the world about, 1.2 million people are killed every year in traffic collisions, and the problem is expecting to get worse, especially in developing low and middle income countries (WHO 2004). Road crashes cost USD 518 billion globally, costing individual countries from 1-2% of their annual GDP) so it is now one of the concerning matter around the world. And research shows that unless proper action is taken road traffic injuries are predicted to become the fifth leading cause of death by 2030 (A report of Association for Safe International Road Travel).

A 1985 study using British and American crash reports as data, found that 57% of crashes were due solely to driver factors, 27% to combined roadway and driver factors, 6% to combined vehicle and driver factors, 3% solely to roadway factors, 3% to combined roadway, driver, and vehicle factors, 2% solely to vehicle factors, and 1% to combined roadway and vehicle factors (Lum and Reagan, 1995). So it is clear that most of the crashes occur due to the driver's fault.

A survey shows that almost 90 percent of road accidents are related to bad driving behavior, driving recklessly and speeding under the influence of alcohol, changing lanes without signaling, driving on the hard shoulder and passing through red lights (Lt Gen Dahi Khalfan, Commander-in-chief of the Dubai Police)

A sample of 1185 fatal vehicle occupant cases was considered, from ten UK police forces, from the years 1994–2005 inclusive. The main findings were: (1) over 65% of the accidents examined involved driving at excessive speed, a driver in excess of the legal alcohol limit, or the failure to wear a seat belt by a fatality, or some combination of these. (2) Young drivers have the great majority of their accidents by losing control on bends or curves, typically at night in rural areas and/or while driving for 'leisure' purposes. These accidents show high levels of speeding, alcohol involvement and recklessness. (3) Older drivers had fewer accidents, but those fatalities they were involved in tended to involve misjudgment and perceptual errors in 'right of way' collisions, typically in the daytime on rural rather than urban roads. Blameworthy right of way errors were notably high for drivers aged over 65 years, as a proportion of total fatal accidents in that age group (Clarke et al, 2010).

Meanwhile, older adults rely on the automobile to maintain their mobility and independence, in spite of the fact that age-related behavioral and biomedical changes may make driving more difficult. Indeed, accident and fatality rates begin to rise after age 55 (Ball and Owsley, 1991).

Older drivers constitute the most rapidly growing segment of the driving population in number of drivers licensed, miles driven, and proportion of the driving population. Yet the highway transportation system has not been designed for these drivers. This lack of fit is reflected in the accelerating rate of crashes per mile driven experienced by older drivers beginning around age 55. Furthermore, older persons are more vulnerable to injury once a crash occurs and as a group experience a higher fatality rate (Waller 1991).

So it is clear that driver’s fault is the main reason behind crash. In case of older drivers, the possibility of accident is higher as misjudgment, perceptual error increases with age. Moreover, they may be physically unfit to drive the vehicles. So proper steps should be taken to sort out those vulnerable group of drivers and there should be a license renewal test for them.

European countries practice a wide range of car driving license renewal procedures. These range from issuing lifelong licenses without subsequent medical checks, to issuing a license to age 70 and for 3- or 5-year periods thereafter based on self-declarations of medical fitness, to requiring medical examinations for renewal, to renewal every 5 years from the age of 45. And there is no evidence that any license renewal procedure or requirement for a medical examination has an effect on the overall road safety of drivers aged 65+, though undoubtedly there are individual drivers who should no longer be driving who might be detected by stringent renewal procedures (Mitchel, 2008).

In developing countries like Bangladesh crashing incidence is too high. The reported road accident and casualty statistics over the past thirteen (1998-2010) years for Bangladesh have showed significant fluctuations. Such fluctuations usually indicate that the statistics are unreliable (probably masking the actual trends) with accidents increasing by some 12 percent between 1998 and 1999 and then peaking in 2003 (4,114 accidents) after dropping quickly in 2001 (decreased by 26 percent compared to year 2000). In 2010 there were about 2,437 reported accidents with 2,443 fatalities and 1,706 injuries (The Daily Star, 2012).

Road accident in Bangladesh claim on an average 12000 lives annually and lead to about 35000 injuries according to Dhaka based accident research institute while according to a World Health Organization (2009) estimates, the count is nearly 20,050.

Typically, the principal contributory factors of accidents according to WHO are as follows:

- Mix of traffic with a variety of vehicle characteristics and speeds.
- Failure to obey mandatory traffic regulations
- Illegal and inconsiderate driving practices.
- Pedestrian/vehicle conflicts.
- Failure to provide and maintain road signs and markings.
- Failure to enforce traffic law.
- Lack of education of road users.
- Poor detailed design of junctions and road sections
- Failure to provide way. Lack of lane discipline.
- Counter-clockwise travel at roundabouts.
- Non-wearing of motorcycle helmets.
- Failure to slow down when approaching an intersection.

So there is a lot of reason behind traffic crashes. If the drivers can be properly trained and traffic laws can be properly applied, crashed incident can be minimized significantly. There should be a process to identify those vulnerable group of drivers who have not properly trained, who cannot memorize the road signs and traffic laws properly after some years of driving.

1.2 Objective of the study

The objective of the study is to determine:

- ❖ Whether the drivers are properly trained or not.
- ❖ If the drivers are familiar with the necessary road signs.
- ❖ Whether the drivers can remember the traffic laws.
- ❖ Whether the drivers are following traffic rules and regulation sincerely while driving.
- ❖ Selection of target group of drivers through road sign testing who are poorly scored.

1.3 Significance of the study:

- We will be able to find the targeted groups of drivers through this study.
- Drivers who score poorly comparing to other groups will be selected as targeted groups.
- There may be an arrangement of further road safety training for the targeted groups
- Thus our study will help to reduce the crash incidents significantly.

1.4 Outline of the thesis:

The thesis is organized into five chapters. After the introduction in first chapter, the other four

Chapters will cover the following topics:

Chapter 2 - Literature review

Factors associated with the driving licensing and relicensing is discussed in this chapter. Earlier studies and their shortcomings by other studies is highlighted here. Moreover, factors affecting drivers test score are also discussed here.

Chapter 3 - Methodology

We will introduce a questionnaire survey in this chapter. We will also describe the data collection procedure in this chapter. The sources of the database used in this study as well as methodology followed in statistical analysis will also be described in this chapter.

Chapter 4 - Model Result and Data Analysis

Report of all findings from the statistical test and their possible outcomes will be analyzed in this chapter. Description of model development and evaluation will also be given as well.

Chapter 5 - Conclusion and Recommendation

The final chapter will provide the summary of the whole study. Main recommendations that arise from the findings will be highlighted here.

Chapter 2

Literature Review

Over the years, many countries around the world have conducted studies to evaluate their licensing policies and components and their effect on attitudes, behavior and traffic accidents.

The Literature review of the thesis will focus on different studies of driving licensing and relicensing procedure and laws from around the world. Factors affecting drivers test score are also discussed here. Many factors such as drivers age restriction, their physical fitness, attitude and behavior, effect of experience and education and their risk taking and crashing probability will be discussed here.

2.1 Driving License Renewal

Generally driving license renewal procedure varies. Normally clean record holders over the previous years are given priority.

Stamatiadis et al (2003) explored that Renewal of driver licenses is usually required every 4 years, and many states (in USA) conduct vision tests before granting renewal. A few states require additional testing, whereas several states have no vision testing or any other examinations at renewal. Stamatiadis et al (2003) proposed a more frequent renewal period accompanied by a vision screening and a medical questionnaire to determine physical and mental status of older drivers.

Kelsey et al (1985) surveyed over 4,000,000 of California's and got that 17,000,000 licensed drivers used to come to the California Department of Motor Vehicles (DMV) annually to take written and vision tests in order to renew their driver licenses. In an effort to increase public convenience and reduce costs, extension of the license by mail was implemented for selected groups of drivers with clean records over the life of their previous licenses. Continued implementation of the program was subject to evaluation of its effect on traffic safety. Since clean-record drivers make up about 50% of the renewal population, this program made it possible for some 2,000,000 drivers annually to avoid coming to the DMV for license renewal. Two studies of program safety effects were conducted, one evaluating a 2-year extension (760,000 subjects), and the other a 4-year extension (407,000 subjects).

A total of 522 drivers 70 and older who were attempting to renew their driver's licenses at licensing offices in Iowa participated in two telephone surveys: one shortly after renewal to discuss driving before renewal and another 6 months later to assess any changes. Of the 522 drivers, 232 renewed their licenses without having to take a road test (Group 1), and 290 were required to take a road test; of the drivers taking a road test, 191 renewed without restrictions (Group 2), 93 received restrictions (Group 3), and 6 had their licenses suspended (Group 4). (Braitman, 2010).

Driver license renewal policies in the United States vary from state to state in terms of the length of the renewal cycle, requirements for accelerated renewal for older drivers, and other renewal provisions.

Molnar et al (2005) note that 17 states (In USA) have special renewal provisions for older drivers, including requirements for in-person renewal, vision tests, or other testing or certification (e.g., written and road tests). Few states require physician or other professional reporting of unfit drivers to licensing agencies, although many encourage physician reporting or at least do not forbid it. Based on the outcomes of these special renewal provisions for older drivers, as well as other information available to licensing agencies, agency personnel have several choices:

- Allow the driver to keep his or her license,
- Refuse to renew the license or suspend,
- Revoke or restrict the license (e.g., prohibit night driving),
- Shorten the renewal cycle.

Kelsey and Janke (1983) explored that Drivers under the age of 70 whose prior 4-year accident and conviction records showed no entries when examined 2 months prior to the date of expiration of their driver licenses were randomly assigned to either a group that renewed licenses in the normal manner or a group that was offered the opportunity to receive a 4-year license extension by mail.

Most states presently do not require increased frequency of license renewal for the older driver, nor do they include periodic retesting using a written examination and road test. The laws regarding such retesting are in a state of change. Screening tests for driving safety must be revised. They should include vision and motor performance testing that is related to driving performance, based on current and continuing research. (JL, 1986).

Stav (2008) stated that states (USA) can achieve a goal of reducing traffic crashes, traffic violations, and traffic-related fatalities through relicensing policies requiring in-person renewal and vision testing as well as driving restrictions.

So driving licensing renewal is very important to minimize the traffic violation and traffic crashes. After every 4 years driving license renewal test should be done. In case of older drivers license renewal is very important. There should be no necessary of written test for them but screening test, vision test and motor performance test should be revised.

2.2 Driving and Aging

Every country has maintained some laws and age restriction for their driving license policies. In general, when the age of driver is higher, the chance of occurring accidents is higher too.

Mitchell (2008) also explored that there is no evidence that any license renewal procedure or requirement for a medical examination has an effect on the overall road safety of drivers aged 65+, though undoubtedly there are individual drivers who should no longer be driving who might be detected by stringent renewal procedures.

Wikman (2005) made a survey and the resulted the older drivers have difficulties in time sharing in highway driving already at the age of 65 to 70 years.

European countries practice a wide range of car driving license renewal procedures. These range from issuing lifelong licenses without subsequent medical checks, to issuing a license to age 70 and for 3- or 5-year periods thereafter based on self-declarations of medical fitness, to requiring medical examinations for renewal, to renewal every 5 years from the age of 45 (Mitchell,2008).

Wood (2002) explored that older people constitute the fastest growing sector of the driving population and are believed to represent a high risk to road safety, given their high crash rate per distance travelled. The crash characteristics of the elderly also differ from those of younger drivers and generally involve multiple vehicles and more complex driving situations. Although the reasons for this deterioration in driving performance are multi-factorial, the age-related changes in vision are likely to be a significant factor, given the important role of vision in driving.

Jl (1986) explored that although individuals over 70 years of age drive fewer miles, the chance of an accident per mile driven is higher because of the multiple changes related to aging. Those changes include decreased sensory perception, slowed information processing, and changes in motor performance. While analyzing the drivers aging JL stated that a field test should be included for drivers over 70 years of age, with a license renewal every 24 months.

Rock (1989) revised the length of license term and renewal requirements for older drivers. The term was shortened from 4 to 2 years for those ages 81–86 and 1 year for those ages 87 and up. A mandatory road test which had been required at renewal for all drivers ages 69 and over, was eliminated for those ages 69 to 74. Data are available to explore the impact of these changes on crashes, fatal crashes, crash rates, and licensure rates of senior drivers.

Cobb and Coughlin (1998) analyzed that elderly drivers are increasing in number and some statistics show they are more likely to be involved in fatal accidents than all other age groups but those under 25. States have attempted to address the problem in various ways, but very few have required mandatory retesting at license renewal for those beyond a particular age.

So from the above discussion it is clear that the chance of an accident per mile driven is higher in case of older drivers. A mandatory road test is required for renewal for all drivers ages 69 and over. And the drivers over 70 year's age need to renew their license after every 24 months.

2.3 Fitness of the Driver

Early studies on dementia and driving generally failed to distinguish between safe and unsafe drivers on the basis of cognitive test performance. Predictive studies demonstrative that cognitively impaired persons as a group perform significantly worse than controls on both neuropsychological and driving measures. A high prevalence of cognitive impairment was found in groups of older drivers involved in traffic accidents and crashes. However, a large range in neuropsychological test scores has been found. Low to moderate correlation could be established between neuropsychological tests results and on road driving performance, making it difficult to determine between cognitively impaired subjects who are fit or unfit to drive. (Withaar et al,2000).

Lloyd el at (2001) explored that In North American society driving is closely linked with independence. Unfortunately, the freedom to operate a motor vehicle may be lost when an individual develops a specific medical diagnosis. The complex issue of dementia and driving safety is frequently encountered by health care professionals. Physicians are required, by law, to report any medical diagnosis such as dementia that may affect driving safety. Physicians often refer to occupational therapists to assist them in determining if an individual's impairment significantly impacts driving safety. Unfortunately, many health care professionals are not using reliable, valid and sensitive tests to determine the point at which an individual with dementia will become an unsafe driver.

Shipp and penchansky (1995) explored that most states require vision screening for driver's license renewal, whereas some do not. Among those states requiring vision screening, there is considerable variation in the frequency and level of testing. Efforts to determine the role of vision in driving, while suggestive, have not been useful in identifying at-risk older drivers. They had also observed that older drivers are often aware of their decreased functional capacity and voluntarily adjust their driving patterns by driving less frequently, for shorter distances, during daylight hours, more slowly, and during non-rush hours. However, although not statistically significant, the decline in the mean annual traffic fatality rates with increased state vision screening requirements suggests a possible beneficial effect of vision screening.

Marchall (2008) explored that Medical conditions overall, do impact the fitness to drive of older drivers; however, the crash risk tends to be only slightly to moderately increased. The conditions can serve as potential warnings for reduced fitness to drive, but many persons with these medical conditions would still be considered safe to continue driving.

Lincoln et al (2006) made a survey to determine whether cognitive tests predict fitness to drive in patients with dementia. They resulted that Safety to drive in people with dementia could be predicted from a combination of six cognitive tests. These correctly identified 67% of safe drivers in a validation sample. This assessment could be used to identify those who need evaluation of their safety on the road.

Roldan el at (1997) explored that the legal requirement to renew a driving license is feared by most symptomatic or already formally diagnosed individuals with Parkinson's disease (PD) as the medical assessment they are required to submit may eventually conclude in withdrawal of their driving license. The purpose of their study was to gain information about PD patients applying for a driving license renovation and their willingness to uncover his or her illness to medical personnel in charge, and how often current medical assessment procedures proved unable to detect abnormalities among parkinsonian applicants who retain data on their health status.

Roldan el at (1997) concluded that at the time of renewal of a driving license parkinsonian patients do not retain problems related to fitness to drive more often than the general population afflicted by other medical conditions do. However, current tests for driving performance appears to be not sensitive enough to detect selective difficulties in motor execution tasks that may impair driving ability in persons with PD.

Studies discussed above showed the importance of fitness of the drivers in case of driving licensing. The lower fitness of the drivers will tend to increase the crash risk. In case of older drivers, cognitive test, screening test should be done for their license renewal. The driver is physically fit, and do not have any problem with dementia etc. should be ensured in license renewal.

2.4 Drivers Attitude and Characteristics

Parker et al (2000) found that drivers over 50 years of age have a higher tendency of Making errors and lapses while driving whereas younger drivers usually violate laws at a higher rate. Moreover, Lajunen and Parker (2001) found that aggressive violations are negatively related to drivers ' age but positively related to annual mileage. The authors concluded that aggressive behavior as a complex phenomenon with a range of Psychological causes.

Different studies have revealed different reasons behind law violations. In a survey Conducted in India, Dandona et al (2005) found that nearly one-third of drivers reported having stopped by police for some violations but only about half of them actually pay fines to police, one-fourth pay bribes and 18% escape somehow. Surprising result is females are less interested to pay fines and reason is described as "getting away by smiling at police personnel".

Machin and Sankey (2008) had researched that inexperienced drivers underestimate the risks associated with a range of driving situations. In addition, personality factors are an important influence on both risk perceptions and driving behavior.

In northern Sweden a survey was made by Sjogren et al (1996). Car drivers who were fatally injured over a 13-year period were investigated using autopsy and police reports. Sjogren et al (1996) found that fatalities per unit distance and per licensed driver were highest for the ≥ 70-year-old and < 25-year-old drivers.

An overview of the characteristics of traffic crashes among young, middle-aged and older drivers was presented by McGwin et al (1999). The results suggest that the youngest and the oldest drivers were more likely to be considered at-fault. With respect to crash characteristics, older drivers were less likely to have crashes involving driver fatigue, during the evening and early morning, on curved roads, during adverse weather, involving a single vehicle, and while traveling at high speeds.

Sjogren et al (1996) explored that fatal head injuries decreased whilst chest injuries increased with age. The ≥ 60-year-old drivers were more likely to die as a consequence of less severe injuries than the < 60-year-old ones. Older drivers got more post-traumatic complications than the younger ones.

From the above findings of the studies reviewed, we can say that the tendency of making error while driving is higher in case of older drivers and the younger drivers generally tend to violate the laws. So in case of driving license renewal test it is important to survey the driver’s characteristics and their attitude like- if the driver is drunken or addicted, if the driver violate the laws of traffic randomly, driver’s crash statistics, driving records over the previous years.

2.5 Effect of Experience and Education

It is very important for the drivers to gain experience for safe driving and proper opportunity should be provided here.

A study was made to investigate the differences between novices and experienced drivers in their distribution of visual attention under different levels of cognitive load imposed by different types of road, and as reflected in their visual search strategies. The results suggested that experienced drivers select visual strategies according to the complexity of the roadway, and that the strategies of novices are too inflexible to meet changing demands, (CRUNDALL and UNDERWOOD, 1998).

Another survey was made by McCartt et al (2003) where Teenagers were surveyed by telephone every 6 months from their freshman to senior high school years (N=911). Self-reported crash involvements and citations were examined for each teenager’s first year of licensure and first 3500 miles driven. Based on survival analysis, the risk of a first crash during the first month of licensure (0.053) was substantially higher than during any of the next 11 months (mean risk per month: 0.025).

The per-mile accident rate of 16-year-old novices is approximately 10 times that of adults, a difference that has been attributed to the immaturity of youth and the errors of inexperience. Research separating the two influences shows that, over the first few years, the effects of experience greatly exceed those of age, with reductions of approximately two-thirds in the first 500 miles of driving (McKnight & McKnight, 2003).

There is no convincing evidence that high school driver education reduces motor vehicle crash involvement rates for young drivers, either at the individual or community level. In fact, by providing an opportunity for early licensure, there is evidence that these courses are associated with higher crash involvement rates for young drivers (Vernick et al, 1999).

Mayhew and Simpson (2002) has explored that Education/training programs might prove to be effective in reducing collisions if they are more empirically based, addressing critical age and experience related factors. At the same time, more research into the behaviors and crash experiences of novice drivers is needed.

From the above discussion it is clear that the experienced drivers can minimize the risk in case of complexity of road way than the novice drivers. Education and proper training can also be effective in reducing collisions. So for driving license, experienced, educated and properly trained drivers should be preferred.

2.6 Speeding and Risk Taking

In general, younger drivers have the more intension than the older drivers to take risk while driving and their average speed is higher also than the older drivers.

In order to understand the mechanisms underlying young drivers' risk-taking behavior in traffic Ulleberg and Rundmo (2003) explored that the relation between the personality traits and risky driving behavior was mediated through attitudes. On this basis it was concluded that personality primarily influences risky driving behavior indirectly through affecting the attitudinal determinants of the behavior.

Leung and Stamer (2005) stated that Young drivers showed a greater tendency to engage in risky driving, while experienced drivers appeared to be more susceptible to perceptual influences.

Finn and Bragg (1986) explored that young drivers are significantly overrepresented among all drivers involved in traffic accidents and fatalities. Excessive risk taking by young drivers appears to be largely responsible for this disproportionate involvement. This excessive risk taking could be due to

-Being more willing to take risks than older drivers are,

-Failing to perceive hazardous situations as being as dangerous as older drivers do or Both-causes.

They also found that young male drivers are overrepresented in traffic accidents at least in part because they fail to perceive specific driving situations as being as risky as older drivers perceive them.

Again based on a survey, Kanellaidis et al (1995) suggested several common reasons for drivers to speed. First, posted speed limits are not reliable or credible to many drivers. Second, Drivers are sometimes in hurry. Third, either police is absent or driver is willing to keep up with traffic. Fourth, drivers often underestimate the risks of speeding and overestimate their driving capabilities. It was proposed that campaigning can increase public awareness to affect speeding behavior and modify compliance with speed limits to acceptance.

An examination of driver risk taking behaviors as revealed in police interviews gave an insight into some of the motivational factors underlying young driver behavior. Young driver accidents of all types are found to be frequently the result of ‘risk taking’ factors as opposed to ‘skill deficit’ factors. It had previously been thought that one of the main problems that young drivers have is in the area of specific skills needed in the driving task. However, it appears that a large percentage of their accidents are purely the result of two or three failures resulting from voluntary risk taking behavior, rather than skill deficits per se. It is shown that specific groups of young drivers can even be considered as above average in driving skills, but simultaneously have a higher accident involvement due to their voluntary decisions to take risks (Clarke et al, 2005).

So it is clear from the above findings that younger drivers have the more tendency of taking risk and breaking speed laws. It is because they lack in skills and experience.so before getting driving license it is important to ensure that they have proper skills and enough experience.

2.7 Effects of Drugs and Alcohol

Holmgren el at (2008) reviewed that a zero-tolerance law for driving under the influence of drugs (DUID) in Sweden led to a 10-fold increase in the number of cases submitted by the police for toxicological analysis. The statutory blood–alcohol concentration (BAC) limit for driving is 0.2 mg/g (∼0.02 g %). They found that 44% of individuals (N = 16,277) re-offended 3.2 times on average (range 1–23 arrests). Between 85 and 89% of first-time offenders were men and there was also a male dominance among the recidivists (88–93%).The median concentration of amphetamine in blood was 1.0 mg/L in recidivists compared with 0.5 mg/L in the first-time offenders. Finally, they concluded that about 14% of drunken drivers re-offended 1–10 times compared with 68% of DUID suspects, who were re-arrested 1–23 times and people with only a scheduled prescription drug in blood were re-arrested much less frequently (∼17%) compared with those taking illicit drugs (68%).

Del Rio et al (2001) made a survey to analyze the alcohol consumption patterns in Spanish drivers. In accordance with Spanish and European Union legislation, driving licenses cannot be issued or renewed to people suffering from alcohol-related problems. Their study reveals that alcohol consumption is common among drivers, that a significant number of drivers have alcohol-related problems, and that three in four of the latter were considered fit to drive.

Zador el at (2000) re-examined and refined the estimates for alcohol-related relative risk of driver involvement in fatal crashes by age and gender as a function of blood alcohol concentration (BAG), by combining crash data from the Fatality Analysis Reporting System with exposure data from the 1996 National Roadside Survey of Drivers. They found that among 16-20-year-old male drivers, a BAC increase of 0.02% was estimated to more than double the relative risk of fatal single-vehicle crash injury. At the midpoint of the 0.08% - 0.10% BAC range, the relative risk of a fatal single-vehicle crash injury varied between 11.4 (drivers 35 and older) and 51.9 (male drivers, 16-20). With only very few exceptions, older drivers had lower risk of being fatally injured in a single-vehicle crash than younger drivers, as did women compared with men in the same age range.

Augsburger and Rivier (1997) examined that epidemiological and analytical laboratory records concerning living drivers suspected of driving under the influence of drug (DUID) during the 13 years' period ranging from 1982 to 1994. Their study included 641 records, 551 men (86%) and 90 women (14%). The average age of the drivers was 27±7 years (n=636, minimum 18 and maximum 74) and the 18–30 interval age range was overrepresented (80%) in this population sample. They found one or more psychoactive drugs in 92.8% of the samples and the majority (58%) of cases presented two or more drugs in biological samples, thus indicating a high incidence of potential interactions between drugs.

Beck el at (1999) performed an investigation to test the effectiveness of a statewide ignition interlock license restriction program for drivers with multiple alcohol-related traffic offenses. They reviewed a total of 1387 multiple offenders eligible for license reinstatement who were randomly assigned to participate in an ignition interlock program (experimental group) or in the conventional post licensing treatment program (control group). The arrest rates of these 2 groups for alcohol traffic offenses were compared for 1 year during the ignition interlock license restriction program and for 1 year after unrestricted driving privileges were returned. They found that participation in the interlock program reduced offenders' risk of committing an alcohol traffic violation within the first year by about 65%.

So from the above discussion it can be summarized that drug and alcohol is very common to the drivers. Drugged and addicted drivers have the possibility of making more road crushes and accidents. So before giving driving license or license renewal it should be ensure that the driver is not suffering from drug or alcohol related problem.

Chapter 3

Methodology

This study is conducted to identify the drivers who are poorly scored through road sign test. This chapter will cover the data collection procedure, formulation of data and the methodology used to identify the less scorer drivers. Linear regression model will be used to identify the different factors affecting the test scores of drivers. The sources of database used in this study are discussed before describing the mathematical formulation of the model, its assumptions and estimation procedures.

3.1 Main Steps in Methodology

In order to achieve the objective of the study, statistical model need to be developed. The model will be developed by surveying the drivers (Bus drivers, Car drivers, Truck drivers) with their socio economic information, licensing & driving experience, attitude and behaviors and their capability of recalling road signs. A total of 300 drivers were surveyed to conduct our study. Then statistically significant factors affecting drivers test score will be identified by analyzing survey data.

The main steps to achieve the objectives are as follows:

1. The questionnaire was prepared by going through different literature and using engineering judgement. The aim of the questionnaire was to know the drivers socio economic information, licensing & driving experience and their attitude and behaviors.

2. Collection of questionnaire survey data from bus drivers, car drivers and truck drivers to develop a discrete model.

3. The collected data will be analyzed using statistical model (Linear Regression) to identify the significant factors.

3.2 Questionnaire Design

According to Statistics Canada (2003), a questionnaire (or form) is a group or sequence of questions designed to obtain information on a subject from a respondent. Questionnaires play a central role in the data collection process since they have a major impact on data quality and influence the image that the statistical agency projects to the public. Questionnaires can either be in paper or computerized format.

3.2.1 Questionnaire Design Process:

Questionnaire design follows some steps described in Statistics Canada, 2003.

First, consulting with data users and respondents is important. Data user consultation starts from formulation of objective. It is extensive and important especially for surveys not conducted by agencies.

Second, review of previous questionnaires may help in all aspects. Careful examination of questions and their same or similar answer makes question designing easier. It is an efficient approach too.

The **third** step involves the drafting the questionnaire. As the whole survey process is affected by the questionnaire drafted, some factors have to be considered for preparing the questionnaire. The way data will be collected will affect wording and placement of questions. Questions should sound natural and more answer categories should be provided in interviews.

The **fourth** step is reviewing and revising the questionnaire. It is helpful in identifying mistakes in spelling and grammar or in wording. People who are not related to survey and experts may review questionnaire and their comments will help to make questionnaires understandable and efficient.

The **last** step in the design process is finalizing the questionnaire. Designing is basically an iterative process and through several iterations, questionnaire is finalized. Final questionnaire is then either printed or programmed based on which data collection method will be used.

3.2.2 Questionnaire

Socio Economic Information

1. Age

a. below 25 years

b. 25-44 years

c. 45-60 years

d. above 60 years

2. Education level

a. < Primary

b. > Primary but < Secondary

c. > Secondary but < Higher secondary

d. > Higher secondary

3. Income

a. <5000 taka

b. 5000-10000 taka

c. 10000-15000 taka

d. >15000 taka

4. How frequently do you drive in a week?

a. Everyday

b. Most days

c. 1 -2 days

d. Rarely

Licensing & Driving Experience

5. How long have you been driving?

a. < 2 years

b. 2-5 years

c. 6-10 years

d. 11-15 years

e. 15 years +

6.How did you learn to drive?

a. took class form driving license schools

b. someone else taught me who is fully licensed

c. someone else taught me who isn't fully licensed

7. How many years ago did you get your license?

a. < 2 years

b. 2-5 years

c. 5-8 years

d. >8 years

8. Did you take any test to get your license?

a. yes

b. no

9. Have the police ever checked your license before?

a. yes

b. no

10. Why did the police check your license?

a. Had an accident

b. Given a fine

c. Routine check

d. Others

11. How many times was your license suspended?

a. none

b.1 time

c. 2 times

d. 3 or more

12. How many accidents did you have in first 2 years of licensing?

a. None

b. 1

c. 2

d. 3 or more

13. How many accidents did you have within last 2 years?

a. None

b. 1

c. 2

d. 3 or more

14. Have you ever gotten into a car accident?

a. yes

b. no

15. Had you paid any monetary fines to police for this accident?

a. yes

b. no

Driver's Attitude and Behaviors

16. Do you obey the traffic rules properly?

a. yes

b. no

17. Do you use a cell phone while driving?

a. always

b. very often

c. sometimes

d. never

18. Have you ever driven while intoxicated with any alcohol?

a. yes

b. no

19. Do you think drinking hampers concentration and prompt driving behavior?

a. yes

b. no

20. Do you think overtaking is a serious problem for crush occurrence?

a. yes

b. no

21. Speeding is one of the main causes of road accidents?

a. yes

b. no

22. Are you familiar with all road signs?

a. yes

b. no

23. Do you wear seat belts while driving?

a. Frequently

b. Sometimes

c. Rarely

d. Never

24. Do you know how many hours a driver can drive at a stress?

a. 3 hours

b. 4 hours

c. 5 hours

d. 6 hours

25. During driving how many times you should look at Side mirror per minute?

a. 3 times
b. 6 times
c. 8 times
d. 10 times

3.2.3 Road Sign Test

The following road signs are being tested by the drivers:

Mandatory Signs

Cautionary signs

Informative signs

3.2 Data Collection:

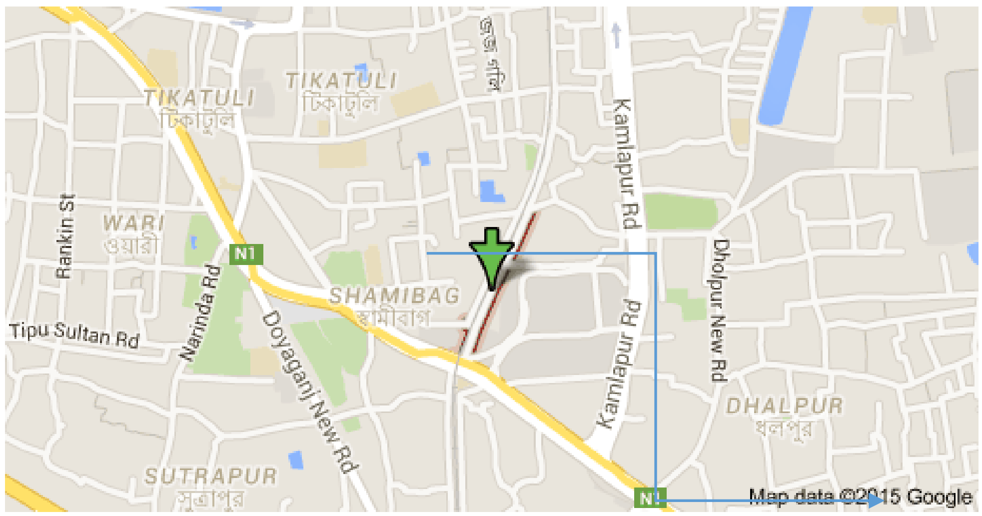
Data collection is typically the greatest single expense in a survey. Because of this problems arising during collection can be very expensive to fix – and could result in overall failure of the project (Statistics Canada, 2003).

We have targeted to survey over 300 drivers. Among them

- 100 are bus drivers
- 100 are car drivers
- 100 are truck drivers

The location for collecting data:

- Board bazar, Saidabad and Abdullahpur bus stand for the bus driver's survey.
- Tongi bus stand for the truck drivers survey
- Islamic University of Technology campus for the car drivers survey



Saidabad

Fig 3.1 the location map of the study area (Source: Google Map)

3.3 Statistical Model

The principal objective of a statistical model is to identify a probabilistic system of the form

$$Y = f(\boldsymbol{X}) \tag{3.1}$$

- Where the dependent variable Y is a function of a set of independent variables X. In the analysis the Y represents the test score of drivers and X represents the age, education, income, experiences, effect of drug & alcohol, recall of traffic rules and road signs, etc.

In our study, most of the dependent variables are continuous. For this reason, linear regression analysis was used in the study.

Linear regression is one of the most widely studied and applied statistical and econometric techniques. It is a useful method for modeling the relationship between a dependent variable and one or more explanatory variables (or independent variable). A lot of reasons are behind this widespread acceptability. First, linear regression is suitable for modeling a wide variety of relationships between variables. In addition, the assumptions of linear regression models are often suitably satisfied in many practical applications. Furthermore, regression model outputs are relatively easy to interpret and communicate to others, numerical estimation of regression models is relatively easy.

3.4.1 Assumptions of the Linear Regression Model

Linear regression is used to model a linear relationship between a continuous dependent variable and one or more independent variables. There are numerous assumptions of the linear regression model, which should be thought of as requirements. When any of the requirements are not met, remedial actions should be taken, and in some cases, alternative modeling approaches should be adopted.

The following assumptions of the linear regression model are explained by following Washington et al. (2010).

3.4.1.1 Continuous Dependent Variable Y

The assumption in regression is that the response is continuous; that is, it can take on any value within a range of values. A continuous variable is measured on the interval or ratio scale. Although it is often done, regression on ordinal scale response variables is incorrect. For example, count variables (nonnegative integers) should be modeled with Poisson and negative binomial regression. Modeling nominal scale dependent variables (discrete variables that are not ordered) requires discrete outcome models.

3.4.1.2 Linear-in-Parameters Relationship between Y and X

The form of the regression model requires that the relationship between variables is inherently linear- a straight-line relationship between the dependent variable Y and the independent variables. The simple linear regression model is given by:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \varepsilon_i \quad (3.2)$$

In this algebraic expression of the simple linear regression model, the dependent variable Y is a function of a constant term β_0 and a constant β_1 times the value X_1 of independent variable X for observation i, plus a disturbance term ε_i. The subscript i corresponds to the individual or observation, where i = 1, 2, 3,….n. In most applications the response variable Y is a function of many independent variables.

3.4.1.3 Observations Independently and Randomly Sampled

An assumption necessary to make inferences about the population of interest is that the data are randomly sampled from the population. Independence requires that the probability that an observation is selected is unaffected by other observations selected into the sample. In some cases, random assignment can be used in place of random sampling, and other sampling schemes such as stratified and cluster samples can be accommodated in the regression modeling framework with corrective measures.

3.4.1.4 Uncertain Relationship between Variables

The difference between the equation of a straight-line and a linear regression model is the addition of a stochastic, disturbance, or disturbance term, ε. This disturbance term consists of several elements of the process being modeled. First, it can contain variables that were omitted from the model — assumed to be the sum of many small, individually unimportant effects, some positive and others negative. Second, it contains measurement errors in the dependent variable, or the imprecision in measuring Y, again assumed to be random. Finally, it contains random variation inherent in the underlying data-generating process.

3.4.1.5 Disturbance Term Independent of X and Expected Value Zero

The requirements of the disturbance term ε can be written as follows:

$$E[\varepsilon_i] = 0 \tag{3.3}$$

And

$$VAR[\varepsilon_i] = \sigma^2 \tag{3.4}$$

Equation 3.4 shows that the variance of the disturbance term, σ^2, is independent across observations. This is referred to as the homoscedasticity assumption and implies that the net effect of model uncertainty, including unobserved effects, measurement errors, and true random variation, is not systematic across observations; instead it is random across observations and across covariates. When disturbances are heteroscedastic (vary systematically across observations), then alternative modeling approaches such as weighted least squares or generalized least squares may be required.

3.4.1.6 Disturbance Terms Not Auto Correlated

This requirement is written as follows:

$$COV[\varepsilon_i, \varepsilon_j] = 0 \text{ if } i \neq j \tag{3.5}$$

Equation 3.5 specifies that disturbances are independent across observations. Common violations of this assumption occur when observations are repeated on individuals, so the unobserved heterogeneity portion of the disturbance term ε is the same across repeated observations. Observations across time often possess auto correlated disturbances as well. When disturbances are correlated across observations, generalized least squares or other correction methods are required.

3.4.1.7 Regressors and Disturbances Uncorrelated

This property is known as exogeneity of the regressors. When the regressors are exogenous, they are not correlated with the disturbance term. Exogeneity implies that the values of the regressors are determined by influences "outside of the model." So Y does not directly influence the value of an exogenous regressor. In mathematical terms, this requirement translates to

$$COV\left[X_i, \varepsilon_j\right] = 0 \text{ for all } i \text{ and } j \tag{3.6}$$

When an important variable is endogenous (depends on Y), then alternative methods are required, such as instrumental variables, two and three stage least squares, or structural equations models.

3.4.1.8 Disturbances Approximately Normally Distributed

Although not a requirement for the estimation of linear regression models, the disturbance terms are required to be approximately normally distributed in order to make inferences about the parameters from the model. In this regard the central limit theorem enables exact inference about the properties of statistical parameters.

3.4.2 Regression Fundamentals

Regression seeks to provide information and properties about the parameters in the population model by inspecting properties of the sample-estimated betas, how they behave, and what they can tell us about the sample and thus about the population.

The linear regression model thought to exist for the entire population of interest is

$$E[Y_i \mid X_i] = E[\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \ldots + \beta_{p-1} X_{p-1,i}] \qquad (3.7)$$

The true population model is formulated from theoretical considerations, past research findings, and postulated theories. The expected value of Y_i given covariate vector X_i is a conditional expectation. In some texts the conditional expectation notation is dropped, but it should be understood that the mean or expected value of Y_i is conditional on the covariate vector for observation i. The population model represents a theoretically postulated model whose parameter values are unknown, constant, and denoted with betas, as shown in Equation 3.7. The parameters are unknown because Equation 3.7 is based on all members of the population of interest. The parameters (betas) are constant terms that reflect the underlying true relationship between the independent variables X1, X2,…,X_{p-1} and dependent variable Y_i, because the population N is presumably finite at any given time. The true population model contains p parameters in the model, and there are n observations.

The unknown disturbance term for the population regression model (Equation 3.7) is given by

$$\varepsilon_i = Y_i - \hat{Y}_i = Y_i - E\left[\beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \ldots + \beta_{p-1} X_{p-1,i}\right] \tag{3.8}$$

Regression builds on the notion that information is learned about the unknown and constant parameters (betas) of the population by using information contained in the sample. The sample is used for estimating betas random variables that fluctuate from sample to sample and the properties of these are used to make inferences about the true population betas. There are numerous procedures to estimate the parameters of the true population model based on the sample data, including least squares and maximum likelihood. The following description is explained from Washington et al. (2010).

3.4.2.1 Least Squares Estimation

Least squares estimation is a commonly employed estimation method for regression applications. Often referred to as "ordinary least squares" or OLS, it represents a method for estimating regression model parameters using the sample data.

Consider the algebraic expression of the OLS regression model shown in Equation 3.7. OLS, as one might expect, requires a minimum (least) solution of the squared disturbances. OLS seeks a solution that minimizes the function Q (the subscript for observation number is not shown):

$$Q_{\min} = \sum_{i=1}^{n} \left(Y_i - \hat{Y}_i \right)_{\min}^2 = \sum_{i=1}^{n} \left(Y_i - (\beta_0 + \beta_1 X_i) \right)_{\min}^2$$

$$= \sum_{i=1}^{n} \left(Y_i - \beta_0 - \beta_1 X_i \right)_{\min}^2 \tag{3.9}$$

Those values of β_0 and β_1 that minimize the function Q are the least squares estimated parameters. Of course β_0 and β_1 are parameters of the population and are unknown, so estimators B_0 and B_1 are obtained, which are random variables that vary from sample to sample. By setting the partial derivatives of Q with respect to β_0 and β_1 equal to zero, the least squares estimated parameters B_0 and B_1 are obtained:

$$\frac{\partial Q}{\partial \beta_0} = -2 \sum_{i=1}^{n} \left(Y_i - \beta_0 - \beta_1 X_i \right) = 0 \tag{3.10}$$

$$\frac{\partial Q}{\partial \beta_1} = -2 \sum_{i=1}^{n} X_i \left(Y_i - \beta_0 - \beta_1 X_i \right) = 0 \tag{3.11}$$

Solving these equations using B_0 and B_1 to denote the estimates of β_0 and β_1, respectively, and rearranging terms yields

$$\sum_{i=1}^{n} Y_i = nB_0 + B_1 \sum_{i=1}^{n} X_i \tag{3.12}$$

$$\sum_{i=1}^{n} X_i Y_i = B_0 \sum_{i=1}^{n} X_i + B_1 \sum_{i=1}^{n} X_i^2 \tag{3.13}$$

Solving simultaneously for the betas in Equations 3.12 and 3.13 yields

$$B_1 = \frac{\sum_{i=1}^{n} (X_i - \overline{X})(Y_i - \overline{Y})}{\sum_{i=1}^{n} (X_i - \overline{X})^2} \tag{3.14}$$

$$B_0 = \frac{1}{n}\left(\sum_{i=1}^{n} Y_i - B_1 \sum_{i=1}^{n} X_i \right) = \overline{Y} - B_1 \overline{X} \tag{3.15}$$

3.4.2.2 Maximum Likelihood Estimation

The previous section showed the development of the OLS estimators through the minimization of the function Q. Another popular and sometimes useful statistical estimation method is called maximum likelihood estimation, which results in the maximum likelihood estimates, or MLEs. The joint density of observing the sample data from a statistical distribution with parameter vector θ, such that

$$f(x_1, x_2, \ldots, x_n, \boldsymbol{\theta}) = \prod_{i=1}^{n} f(x_i, \boldsymbol{\theta}) = L(\boldsymbol{\theta} \mid \mathbf{X}) \tag{3.16}$$

For the regression model, the likelihood function for a sample of n independent, identically, and normally distributed disturbances is given by

$$L = \left(2\pi\sigma^2\right)^{-\frac{n}{2}} EXP\left[-\frac{1}{2\sigma^2}\sum_{i=1}^{n}\left(Y_i - X_i^T\beta\right)^2\right]$$

$$= \left(2\pi\sigma^2\right)^{-\frac{n}{2}} EXP\left[-\frac{1}{2\sigma^2}(Y - X\beta)^T(Y - X\beta)\right] \tag{3.17}$$

As is usually the case, the logarithm of Equation 3.17, or the log likelihood, is simpler to solve than the likelihood function itself, so taking the log of L yields

$$LN(L) = LL = -\frac{n}{2}LN(2\pi) - \frac{n}{2}LN\left(\sigma^2\right) - \frac{1}{2\sigma^2}(\mathbf{Y} - \mathbf{X\beta})^T(\mathbf{Y} - \mathbf{X\beta}) \tag{3.18}$$

Maximizing the log likelihood with respect to β and σ^2 reveals a solution for the estimates of the betas that is equivalent to the OLS estimates, that is $B = (X^TX)^{-1}X^TY$.

3.4.3 Regression Model Goodness-of-Fit Measures

According to Washington et al. (2010) goodness-of-fit (GOF) statistics are useful for comparing the results across multiple studies, for comparing competing models within a single study, and for providing feedback on the extent of knowledge about the uncertainty involved with the phenomenon of interest. Three measures of model GOF are discussed: R-squared, adjusted R-squared, and the generalized F test. To develop the R-squared GOF statistic, some basic notions are required. Sum of squares and mean squares are fundamental in both regression and analysis of variance. The sum of square errors (disturbances) is given by

$$\text{SSE} = \sum_{i=1}^{n} \left(Y_i - \hat{Y}_i \right)^2 \tag{3.19}$$

The regression sum of squares is given by

$$\text{SSR} = \sum_{i=1}^{n} \left(\hat{Y}_i - \overline{Y} \right)^2 \tag{3.20}$$

And the total sum of squares is given by

$$\text{SST} = \sum_{i=1}^{n} \left(Y_i - \overline{Y} \right)^2 \tag{3.21}$$

The SSE is the variation of the fitted regression line around the observations. The SSR is the variation of the fitted regression line around, and SST is the total variation — the variation of each observation around. It also can be shown algebraically that SST = SSR + SSE. Mean squares are just the sum of squares divided by their degrees of freedom. SST has n-1 degrees of freedom, because 1 degree of freedom is lost in the estimation of Y. SSE has n – p degrees of freedom, because p parameters are used to estimate the fitted regression line. Finally, SSR has p – 1 degrees of freedom associated with it. As one would expect, the degrees of freedom are additive such that n – 1 = n – p + p – 1. The mean squares, then, are MSE = SSE/(n – p) and MSR = SSR/(p – 1). The coefficient of determination, R-squared, is defined as

$$R^2 = \frac{[\mathrm{SST} - \mathrm{SSE}]}{\mathrm{SST}} = \frac{\mathrm{SSR}}{\mathrm{SST}} = 1 - \frac{\mathrm{SSE}}{\mathrm{SST}} \qquad (3.22)$$

R^2 can be thought of as the proportionate reduction of total variation accounted for by the independent variables (X). It is commonly interpreted as the proportion of total variance explained by X. When SSE = 0, $R^2 = 1$, and all of the variance is explained by the model. When SSR = 0, $R^2 = 0$, and there is no association between X and Y. Because R^2 can only increase when variables are added to the regression model (SST stays the same, and SSR can only increase even when statistically insignificant variables are added), an adjusted measure, R^2_{adjusted}, is used to account for the degrees of freedom changes as a result of different numbers of model parameters, and allows for a reduction in R^2_{adjusted} as additional, potentially insignificant variables are added. The adjusted measure is considered to be superior for comparing models with different numbers of parameters. The adjusted coefficient of multiple determinations is

$$R^2_{\mathrm{adjusted}} = 1 - \frac{\frac{\mathrm{SSE}}{n-p}}{\frac{\mathrm{SST}}{n-1}} = 1 - \left(\frac{n-1}{n-p}\right)\frac{\mathrm{SSE}}{\mathrm{SST}} \qquad (3.23)$$

The following guidelines should be applied:

- The R^2 and $R^2_{adjusted}$ measures provide only relevant comparisons with previous models that have been estimated on the phenomenon under investigation. Thus, an $R^2_{adjusted}$ of 0.40 in one study may be considered "good" only if it represents an improvement over similar studies and the model provides new insights into the underlying data-generating process. Thus, it is possible to obtain an improvement in the R^2 or $R^2_{adjusted}$ value without gaining a greater understanding of the phenomenon being studied. It is only the combination of a comparable $R^2_{adjusted}$ value and a contribution to the fundamental understanding of the phenomenon that justifies the claim of improved modeling results.

- The absolute values of R^2 and $R^2_{adjusted}$ measures are not sufficient measures to judge the quality of a model. Thus, an R^2 of 0.20 from a model of a phenomenon with a high proportion of unexplained variation might represent a breakthrough in the current level of understanding, whereas an R^2 of 0.90 of another phenomenon might reveal no new insights or contributions. Thus, it is often better to explain a little of a lot of total variance rather than a lot of a little total variance.

- Relatively large values of R^2 and $R^2_{adjusted}$ can be caused by data artifacts. Small variation in the independent variables can result in inflated values. This is particularly troublesome if in practice the model is needed for predictions outside the range of the independent variables. Extreme outliers can also inflate R^2 and $R^2_{adjusted}$ values.

- The R^2 and $R^2_{adjusted}$ assume a linear relation between the response and predictor variables, and can give grossly misleading results if the relation is nonlinear. In some cases R^2 could be relatively large and suggest a good linear fit, when the true relationships are curvilinear. In other cases, R^2 could suggest a very poor fit when in fact the relationships are nonlinear. This emphasizes the need to plot, examine, and become familiar with data prior to statistical modeling.

- The R^2 and $R^2_{adjusted}$ values are bound by 0 and 1 only when an intercept term is included in the regression model. When the intercept is forced through zero, the R^2 and $R^2_{adjusted}$ values can exceed the value 1 and more caution needs to be used when interpreting them.

Another measure for assessing model fit is the generalized F test. This approach is a general and flexible approach for testing the statistical difference between competing models. First, a full or unrestricted model is estimated. This could be a model with ten independent variables. The full model is fit using the method of least squares and SSE is obtained — the sum of square errors for the full model. For convenience, the sum of square errors for the full model is denoted as

$$\mathrm{SSE}_F = \sum_{i=1}^{n} (Y_i - \hat{Y}_{Fi})^2 \tag{3.24}$$

Where the predicted value of Y is based on the full model.

A reduced model is then estimated, which represents a viable competitor to the full model with fewer variables. For example, this could be a model with nine independent variables, or a model with no independent variables, leaving only the Y-intercept term B_0. The sum of squared errors is estimated for the competing or reduced model, where

$$\text{SSE}_R = \sum_{i=1}^{n} (Y_i - \hat{Y}_{Ri})^2 \tag{3.25}$$

The logic of the F test is to compare the values of SSE_R and SSE_F. Recall from the discussion of R-squared that SSE can only be reduced by adding variables into the model, thus $SSE_R \geq SSE_F$. If these two sum of square errors are the same, then the full model has done nothing to improve the fit of the model; there is just as much "lack of fit" between observed and predicted observations as with the reduced model, so the reduced model is superior. Conversely, if SSE_F is considerably smaller than SSE_R, then the additional variables add value to the regression by adding sufficient additional explanatory power. In the generalized F test the null and alternative hypotheses are as follows:

$$H_0\text{: all } \beta_k = 0 \tag{3.26}$$

$$H_a\text{: all } \beta_k \neq 0 \tag{3.27}$$

In this test the null hypothesis is that all of the additional parameters in the full model (compared to the reduced model) β_k are equal to zero.

When the null hypothesis is true (making the F test a conditional probability), the F* statistic is approximately F distributed, and is given by

$$F^* = \frac{\dfrac{\text{SSE}_R - \text{SSE}_F}{df_R - df_F}}{\dfrac{\text{SSE}_F}{df_F}} \approx F\left(1-\alpha; df_R - df_F, df_F\right) \tag{3.28}$$

Where $df_F = n - p_F$ and $df_R = n - p_R$ (n is the number of observations and p is the number of parameters). To calculate this test statistic, the sum of square errors for the two models is first computed, then the F* statistic is compared to the F distribution with appropriate numerator and denominator degrees of freedom. Specifically,

$$\begin{aligned} &\text{If } F^* \leq F(1-\alpha; df_R - df_F, df_F), \text{ then conclude } H_0 \\ &\text{If } F^* \geq F(1-\alpha; df_R - df_F, df_F), \text{ then conclude } H_a \end{aligned} \quad (3.29)$$

The generalized F test is very useful for comparing models of different sizes. When the difference in size between two models is one variable, the F test yields an equivalent result to the t test for that variable. Thus, the F test is most useful for comparing models that differ by more than one independent variable.

Following Montgomery and Runger (2003) the hypotheses of t-test are

$$H_0: \beta_1 = \beta_{1,0} \quad (3.30)$$

$$H_1: \beta_1 \neq \beta_{1,0} \quad (3.31)$$

Where we have assumed a two-sided alternative and the t-statistics is

$$T_0 = \frac{\hat{\beta}_1 - \beta_{1,0}}{\sqrt{\hat{\sigma}^2/S_{xx}}} \qquad (3.32)$$

Follows the t distribution with (n-2) degrees of freedom under $H_0:\beta_1=\beta_{1,0}$. We would reject $H_0:\beta_1=\beta_{1,0}$ if

$$|t_0| > t_{\alpha/2,n-2} \qquad (3.33)$$

Where t_o is computed from Equation 3.33.

The denominator of Equation 3.33 is the standard error of slope. So, we could write the test statistic as

$$T_0 = \frac{\hat{\beta}_1 - \beta_{1,0}}{se(\hat{\beta}_1)} \qquad (3.34)$$

3.4.4 Elasticity of Variables

In order to check the relative significance of independent variables from the final model, the elasticity of the variables was calculated. Elasticity is defined as the percent change in dependent variable due to one percent change in the independent variable. Chang (2005) explained, in general the direct elasticity is defined as

$$E_{x_{ij}}^{\lambda_i} = \frac{\partial \lambda_i}{\partial x_{ij}} \cdot \frac{x_{ij}}{\lambda_i} \tag{3.35}$$

Where E represents the elasticity, x_{ij} is the value of variable j of community i. Equation 3.35 is transformed into following equation

$$E_{x_{ij}}^{\lambda_i} = \beta_j x_{ij} \tag{3.36}$$

Where, β_j is the coefficient corresponding to variable j.

The elasticity in Equation 3.36 is only appropriate for continuous variables. It is not valid for non-continuous variables such as indicator variables that take on values of 0 or 1. For an indicator variable, a pseudo-elasticity is computed to estimate an approximate elasticity of the variables. The pseudo-elasticity gives the incremental change in frequency caused by a discrete (0-1) change in the indicator variables. The pseudo-elasticity for indicator variable is computed as:

$$E_{x_{ij}}^{\lambda_i} = \frac{\exp(\beta_j) - 1}{\exp(\beta_j)} \tag{3.37}$$

Chapter 4

Model Development and Data Analysis

4.1 Overview

In this chapter we will discuss in detail how the model has been developed. Report of all findings and their possible outcomes will be analyzed in this chapter. Different variables, their significance & justification will also be discussed here. Some factors which may have influence on the test score of the drivers is identified here. It also discusses the goodness of our model.

4.2 Model Development

We have used multiple linear regression model for the analysis of data. A total of 300 Samples were collected. After conducting the survey we used final data sheet for the 'STATA' analysis. Summary statistics of the variables are shown below in table 4.1

Table 4.1: Summary Statistics of Variables

Variables	Mean	Std. DV
Drivers		
Bus Drivers	0.333	0.472
Car Drivers	0.333	0.472
Truck Drivers	0.333	0.472
Age		
Age - below 25 Years	0.18	0.385
Age - between 25-44 Years	0.443	0.498
Age - between 45-60 Years	0.31	0.463
Age - greater than 60 Years	0.063	0.244
Education level		
Education level - less than primary	0.227	0.419
Education level - primary to secondary	0.407	0.492
Education level - secondary to Higher secondary	0.313	0.465
Education level - greater than Higher secondary	0.053	0.225
Drive in a week		
Drive in a week - everyday	0.41	0.493
Drive in a week - most days	0.5	0.507
Drive in a week - 1-2 days	0.09	0.287
Drive in a week - rarely	0	0
Learn to drive		
Learn to drive from Driving license schools	0.337	0.473
Learn to drive from Someone fully licensed	0.643	0.479
Learn to drive from Someone not fully licensed	0.02	0.140
Years of getting license		
Years of getting license less than 2 years	0.08	0.277
Years of getting license 2-5 years	0.14	0.348
Years of getting license 5-8 years	0..173	0.379
Years of getting license greater than 8 years	0.607	0.489
Reasons of License checking		
Reasons of License checking by police - Accidents	0.122	0.329
Reasons of License checking by police - Given a fine	0.063	0.329
Reasons of License checking by police - Routine check	0.503	0.501
Reasons of License checking by police - Others	0.312	0.465

Variables	**Mean**	**Std. DV**
License suspension		
License suspension - none	0.96	0.196
License suspension - 1 time	0.03	0.171
License suspension - 2 times	0.01	0.082
License suspension - 3 times	0	0
Accidents Within Last Two Years Of Licensing		
Accidents Within Last Two Years Of Licensing-None	0.447	0.498
Accidents Within Last Two Years Of Licensing-one times	0.376	0.485
Accidents Within Last Two Years Of Licensing-Two times	0.13	0.337
Accidents Within Last Two Years Of Licensing-Three or more	0.047	0.211
Obey The Traffic Rules		
Obey The Traffic Rules Properly-Yes	0.973	0.161
Obey The Traffic Rules Properly-No	0.027	0.161
Driven Intoxicated With Alcohol		
Driven Intoxicated With Alcohol-Yes	0.27	0.443
Driven Intoxicated With Alcohol-No	0.73	0.445
Wear Seat Belts While Driving		
Wear Seat Belts While Driving-Frequently	0.41	0.493
Wear Seat Belts While Driving-Sometimes	0.23	0.082
Wear Seat Belts While Driving-Rarely	0.113	0.337
Wear Seat Belts While Driving-Never	0.247	0.432

Since factors are recorded in a categorical manner, binary variables (0 or 1) are used to capture their effects. For example, the education level of the drivers is categorized by four types of variables:

- Education level - less than primary
- Education level - primary to secondary
- Education level - secondary to Higher secondary
- Education level - greater than Higher secondary

If a driver is less educated than primary it will be denoted as 1 otherwise 0. This is same for all other categories.

Bus, car and truck drivers are almost equal in number (33.33%). Note that the mean of a variable simply represents the proportion of the sample belonging to the particular category. For example, the age of the drivers is captured by four variables.

- Age - below 25 Years
- Age - between 25-44 Years
- Age - between 45-60 Years
- Age - greater than 60 Years

Therefore, the mean of the age below 25 years is 0.18 which indicates that 18 % of the sample has belonging age below 25 years. The majority of the drivers (41.33%) drive every day in a week and major numbers of driver (64.33 %) learn to drive from someone who is fully licensed. 97.33 % of drivers obey the traffic rules properly while 24.67 % of drivers do not wear seat belts while driving.

Categorical data always sum to one or 100 %, one of the categories has to be omitted from the model and used as a reference or base case by which the estimates of other categorical variables are compared. In case of interpreting the model results, the positive sign of the estimated coefficients **β** indicate the higher chances of getting high test score as the value of the associated variables increases while negative signs suggest the converse.

4.3 Model Result and Interpretation

Here we will highlight the significant variables and also the coefficient, standard error and p-value of the multiple linear regression analysis against each of the significant variables. Result of Multiple Linear Regression Analysis on identification of vulnerable groups of driver through road sign test is given below in table 4.2.

Table 4.2: Linear regression model for Identification of Vulnerable Groups of Driver

Number of observation	**=**	**300**
F (20, 279)	**=**	**3.87**
Prob > F	**=**	**0.0000**
R-squared	**=**	**0.2171**
Adj R-squared	**=**	**0.1609**

Variables	Coefficient	Std. Err.	P-Value
Drivers			
Bus Drivers	- 0.744	0.234	0.002
Car Drivers	- 0.815	0.255	0.002
Age			
Age - below 25 Years	- 0.734	0.258	0.005
Age - between 25-44 Years	- 0.672	0.287	0.020
Age - between 45-60 Years	- 1.930	0.474	0.000
Education level			
Education level - less than primary	- 0.506	0.231	0.029
Education level - greater than Higher secondary	0.706	0.389	0.071

Variables	Coefficient	Std. Err.	P-Value
Drive in a week			
Drive in a week - everyday	0.114	0.180	0.529
Learn to drive			
Learn to drive from Driving license schools	- 1.029	0.618	0.097
Learn to drive from Someone fully licensed	- 0.978	0.603	0.106
Years of getting license			
Years of getting license 2-5 years	- 0.455	0.273	0.097
Reasons of License checking by police			
Reasons of License checking by police - Routine check	- 0.472	0.237	0.048
Reasons of License checking by police - Others	- 0.556	0.251	0.028
License suspension			
License suspension - none	- 2.098	0.839	0.013
License suspension - 1 time	- 1.969	0.966	0.042
Accidents Within Last Two Years Of Licensing			
Accidents Within Last Two Years Of Licensing-None	0.648	0.289	0.023
Accidents Within Last Two Years Of Licensing-one times	0.559	0.266	0.036
Obey The Traffic Rules			
Obey The Traffic Rules Properly-Yes	1.158	0.529	0.029
Driven Intoxicated With Alcohol			
Driven Intoxicated With Alcohol-No	0.455	0.201	0.024
Wear Seat Belts While Driving			
Wear Seat Belts While Driving-Sometimes	- 0.402	0.199	0.045
Constant	12.311	1.223	0.000

The table only shows the statistically significant categories of variables entered, and thus helped producing a more statistically significant model with p-value<0.1. Note that only variables with at least a ninety percent confidence level have been retained in the model. Thus p- values of variables are generally less than 0.1. Based on data analysis in STATA we have got 20 significant variables among 84 variables from 300 observations. In general, the model had a good goodness-of-fit statistic as assessed by the relatively high R-square and adjusted R-square as well as low p-value of F-test.

Standard error of each variable shows the measurement of error of each variable in the regression analysis. R^2 value suggested that 21.71% of the variance of the driver's test score could be explained by the significant categories. R^2 value of 1.00 is the best statistical model.

Among the factors considered in this study, a number of factors which proved to have influence on driver's test score are discussed in this section. When compared to the truck drivers, bus drivers and car drivers have scored less in the test. Because may be truck drivers are more concerned about road safety as it is a bigger vehicle. They may have to follow the road sign strictly because as it is a bigger vehicle it can be responsible for more traffic congestion and crash incidence. Again in the comparison between bus drivers and car drivers bus drivers have scored more positively than car drivers. This may happen because bus drivers normally drive more usual than car drivers. So bus drivers may recall the road sign more than the car drivers which may have impact on their test score.

Drivers who are aged below 25 years, have scored more than the drivers who are above 25 years. This may happen because the drivers who are below 25 years are young and energetic. They may have given their driving license test recently. So they may recall road sign comparatively better than the aged drivers. Our model result shows that drivers having ages greater than 60, are the least scorers. Older driver's vision, hearing, physical mobility, and cognitive processes might affect their test score. They are experienced but after so many years of license test and due to their physical condition they mightn't remember the road sign properly. According to RW et al (2004) the population is becoming increasingly aged and concomitantly, the prevalence of dementia is steadily rising. Persons aged 65 years and over are likely to continue driving for many years and often well into the dementia process.

Higher education positively affects the test score of our model. Our model shows that drivers who are educated above higher secondary ($\beta = .7064896$, $p= 0.071$) are more likely to remember the road sign than the drivers who are educated below primary ($\beta = -0.5062741$, $p= 0.029$). Perhaps drivers who are more educated are more careful and sincere.

They may drive according to proper rules and regulation and they may follow road sign properly while driving. This perhaps help them to boost their score. Mayhew et al (1998) proved that driver education provides safety benefits.

Drivers who drive every day in a week appear to be more concerned about road sign compared to the drivers who drive often and rarely. A probable reason is that drivers who drive everyday are more familiar with road sign. As they spent more hours on road they may eventually more familiar with road sign and that may help them to recall the road sign.

Our model shows that drivers who learned to drive from someone fully licensed (β= -0.9780816, p=0.106) has scored more rather than the drivers who learned from driving school (β= -1.029086, p= 0.097). A probable reason might be that in driving school they may not have proper training equally and that might affect their confidence. An experiment was conducted by Gregersen (1994) between professionally supported educated drivers and drivers who are trained by parents or other private teachers. The result shows that professionally supported educated drivers are being a little more careful and a little less self-confident. Drivers who learned from fully licensed person have the opportunity to learn briefly and properly. They take more time to learn but this perhaps help them to learn properly. Therefore, it may have an impact on their test score.

When it comes to years of getting license, the drivers who got their licenses 2-5 years ago tend to score less compared to drivers who got their license less than 5-8 years or more years ago. A probable reason is that drivers who got their licenses 5-8 years or more years ago may drive according to proper rules and regulation and they may follow road sign properly while driving because they can recall the road signs and traffic rules easily from their experience in the road. Again our result shows that drivers who got their license less than two years ago have scored more than the drivers who got their licenses 2-5 years ago. This may happen because drivers who got their license less than two years ago can recall most of the traffic rules and road sign from their recent driving licensing test.

Drivers whose licenses are checked by police for committing accidents or have given fines for various occasions score positively compared to the drivers whose licenses are checked by police for routine check or other reasons. The probable reason is drivers whose licenses are checked by police for committing accidents or have given fines more cautious and careful while driving and they may obey the traffic rules and road signs to avoid any unnecessary mishaps.

License suspension seems to have influence on the test score of the drivers. Those drivers who never got their license suspended or their license may have suspended for one time have scored less than the drivers who got their license suspended for 2 or 3 times. A probable reason is that drivers who got their license suspended are more careful and sincere and they take necessary precautions to avoid further license suspension while driving. On the contrary drivers who never got their license suspended are more careless and reckless while driving and they tend to break the traffic rules and don't obey the road signs properly.

Drivers who did not get into any accidents or may have faced an accident within last two years of their licensing have scored more than the drivers who got into accidents for 2 or more times within last two years of their licensing. Perhaps those drivers who got into accidents for 2 or more times within last two years of their licensing are more careless and reckless while driving and may have forgotten the road signs and traffic rules. This may impact negatively on their test score. On the other hand, drivers who did not get into accidents or faced an accident within last two years of their licensing may follow the traffic rules and road signs properly while driving. Perhaps they are more experienced and careful in road while driving and this may have helped them to boost their score.

According to the results of regression analysis, drivers who obey the traffic rules properly have scored more than drivers who don't obey the traffic rules. Likely to be these group of drivers are more educated and experienced and they may drive according to proper rules and regulations and they may follow road signs properly while driving. This perhaps help them to boost their scores.

Our model shows that drivers who are not under the influence of alcohol while driving have scored more than the drivers who are under the influence of alcohol. The probable reason is that drivers who are not under the influence of alcohol can judge the vehicle's position on the road, or the location of other vehicles, center line or road signs. They may also be able to make rational decisions and react swiftly to changing situations.

Among the other statistically significant variables, drivers who wear seat belts sometimes while driving ($\beta = -0.402$, $p=0.045$) have scored less compared to those drivers who wear seat belts frequently or rarely. Perhaps these drivers are less experienced and careless of using seat belts while driving. They may have given importance in following the traffic rules and regulations and road signs rather wearing the seat belts while driving.

Chapter 5

Conclusion and Recommendation

5.1 General Discussion

This chapter summarizes the outcome of the study. The effectiveness of the study and how people can be benefited from this study are discussed in short in this part. The limitations of the research conducted are discussed together with some directions for future research.

5.2 Necessity of Our Study

Road safety is a vital issue throughout the world. If the drivers are properly trained, if they maintain traffic rules properly, if they follow road sign with care, road crashes and congestion could be minimized significantly. And this will help to improve road safety scenarios.

The main objective of our study was to identify the selected group of drivers through road sign test who have less knowledge.

5.3 Outcomes & Application of Our Study

A number of variables, assumed to have relations to the reassessing road sign test of drivers interviewed were selected and assessed at a 90% confidence interval. Only linear regression modeling was consulted to develop this statistical model. In the final model 20 individual variables proved to have statistical significance. Meaning, we found these 20 variables directly affecting the test score of the drivers. **Detailed discussions are provided in section 4.3**

From our analysis we found,

- bus drivers
- car drivers
- older drivers
- less educated drivers
- drivers who rarely drive
- drivers who learned from driving school
- drivers who got their licenses 2-5 years ago
- drivers whose licenses are checked by police for routine check or other reasons
- drivers who never got their license suspended or their license may have suspended for one time
- drivers who got into accidents for 2 or more times within last two years of their licensing
- drivers who do not obey the traffic rules properly
- drivers who are under the influence of alcohol
- drivers who cannot recall the necessary road signs
- drivers who wear seat belts sometimes

Have scored less in comparison to other groups and they are our targeted group of drivers.

If any road safety training is introduced, then this selected groups of driver should get the priority first. It would be a better idea to train all the drivers after some years of their driving. But in country like Bangladesh it would not be economically feasible. So our study will help to identify those targeted group of drivers who need further training.

5.4 Limitations and Future Extension of the Study

This research is not without its limitations. The data used in this study have the following limitations:

- The study relies on a sample of drivers from the capital city, Dhaka. The sample is representative of urban drivers; it does not include rural drivers. Care should be exercised when generalizing the results.
- It was very difficult for us to survey in different place because sometimes people are not interested in this type of survey.
- The respondents do not reveal real information for some particular questions.
- The respondents hide their personal information.
- We don't have any previous experience of writing this type of report that is why we faced some problems to prepare the report.

Apart from the study that has been carried out, there is scope for further studies especially on the following area:

- ❖ Since this study is only focused on Dhaka, more research needs to be conducted to confirm the findings. In future if it is possible we would like to carry out our research on different parts of the country.
- ❖ Further analysis can be done on driver's relicensing that will overall help to improve road crashes incidents.
- ❖ We can also utilize multivariate statistical models to increase the efficiency of our research and control for interdependency among the data.

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