Causes of female teacher work trip accidents in the Kingdom of Saudi Arabia

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Civil Engineering

March 2003

Abstract

Victims of road traffic accidents and the resulting casualties are continuously increasing. In Saudi Arabia traffic accidents are among the major causes of death, particularly for the female travelers group. The local custom and religion abide females to drive for their work trips. They therefore depend on drivers (their spouse or any other male driver) to reach their work. Many of them travel long distances for their work trips. This research attempts to find the potential factors which are involved in the accident creation. Data was collected all over the kingdom of Saudi Arabia from schools and colleges. The possible causes studied include: the driver, femal traveling attributes, vehicle characteristics, and the environment. The research includes the results, showing the order of significance of the accident causing factors interactions along with a detailed interpretation and discussion of the data. Further it was noted that there is an urgent need for improvement of safety standards in different provinces of the Kingdom.

Causes of Female Teacher Work Trip Accidents in the Kingdom of Saudi Arabia

BY

Zeeshan Raza Abdy

A Thesis Presented to the
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Dedicated to

My Father and my

IDEAL PERSONALITY

PROFESSOR BADRUL HASAN ABDY

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First and foremost, all praise to the Almighty Allah, Who gave me courage and patience to carry out this work. I am happy to have had a chance to glorify His name in the sincerest way through this small accomplishment and ask Him to accept my efforts. May He guide us and the whole humanity along the right path (*Aameen*).

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حقل التخصص : الهندسة المدنية

تاريخ منح الدرجة : مارس ٢٠٠٣م

ان ضحايا الحوادث المرورية والاعراض الناتجة في ازدياد مستمر. في المملكة العربية السعودية، ان الحوادث المرورية من الاسباب الاساسية لحدوث الوفيات، خاصة لمجموعات الاناث المسافرات. ان التقاليد المحلية والدينية تقيد قيادة المرآة لأغرتض رحلات العمل. ويعتمدن، اذا، على السائقين (أزواجهن أو أي سائق ذكر) للوصول الى اماكن عملهن. ان العديد منهن يقطعن مسافات طويلة لرحلات عملهن. ان هذا البحث يحاول الوصول للعوامل الممكنة التي تدخل في حدوث الحوادث. جمعت البيانات من جميع مناطق المملكة، من المدراس والكليات. ان الاسباب المحتملة المدروسة تحتوي: السائق، اسباب السفر، خواص المركبة، والبيئة. يحوي البحث النتائج، موضحا درجة أهمية تفاعل العوامل المسببة للحادث مع تحليل تفصيلي ومناقشة البيانات. اضافة، لوحظ الحوجة الماسة لتحسين المعايير الثابتة للامان بمختلف محافظات المملكة.

درجة الماجستير في العلوم

جامعة الملك فهد للبترول والمعادن

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THESIS ABSTRACT

Name of Researcher: **Zeeshan Raza Abdy**

Title of Research Study: **A study on the causes of female teacher work trip accidents in the Kingdom of Saudi Arabia**

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Victims of road traffic accidents and the resulting casualties are continuously increasing. In Saudi Arabia, traffic accidents are among the major causes of death, particularly for the female travelers group. The local custom and religion abide females to drive for their work trips. They therefore depend on drivers (their spouse or any other male driver) to reach their work. Many of them travel long distances for their work trips. This research attempts to find the potential factors which are involved in the accident creation. Data was collected all over the kingdom of Saudi Arabia from schools and colleges. The possible causes studied include: the driver, female traveling attributes, vehicle characteristics, and the environment. The research includes the results, showing the order of significance of the accident causing factors interactions along with a detailed interpretation and discussion of the data. Further it was noted that there is an urgent need for improvement of safety standards in different provinces of the kingdom.

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Chapter 1

INTRODUCTION

1.1. General

The Kingdom of Saudi Arabia is a large country, having an area of over 2.2 million square kilometers (km^2), occupying an area approximately the size of western Europe or one-fourth the size of the United States. The distance from the capital city, Riyadh, to Jeddah (east to west) is approximately the same as that from Berlin to London. The population is scattered throughout the country, with major concentrations in several distinctive regions.

In the oil rich Arabian Gulf countries, many aspects of life changed shortly after the discovery of oil. There was an explosion of both population and number of vehicles, accompanied by rapidly expanding road construction.

The Kingdom has witnessed dramatic and rapid change in all fields of activity, including the transportation and communications sectors. The government of Saudi Arabia also took up the challenge and developed a road program covering great distances, under extreme climate and topographical conditions. As a result, the number of private cars and commercial vehicles such as buses and trucks has also increased. Bener (1990) reported that, unfortunately, patterns of behavior did not change so rapidly.

Roads constitute more fatalities than any other non-road mode of travel [see Evans (1994).] The result is a large and growing number of casualties caused by traffic accidents.

Jacobs and Cutting (1986) reported that with each passing day, in most of the countries in the world, traffic accidents inflict a staggering amount of destruction. The toll in terms of loss of life and limb, plus the socio-economic cost to society, is high and getting higher. Traffic accidents are not simply a loss of life but they are a unrecoverable setback to all those concerned from which it will be difficult to recover. Each year millions of persons are killed or seriously injured in motor vehicle accidents.

Mc Carthy (1987) estimated that more than 200 persons are killed or seriously injured every hour on United States roadways and that traffic accidents are the leading cause of death in youth.

Road traffic fatalities have been a major leading cause of morbidity and mortality in developed and developing countries [see Bener 1990.] Various pieces of research carried out on traffic accidents in developing countries, like Jacobs (1982), and in rich developing countries (Bayoumi 1981; Mekky 1985; Ergun 1988; Jadaan 1989; and Ofosu et al 1988) have revealed that, compared to many western industrialized countries. developing countries have a severe increase in mortality rates due to road injuries.

Jacobs and Cutting (1986) in their study of accidents in a number of developing countries showed that the traffic safety situation is worsening in many developing countries. There is a persistent downward trend in fatality, and fatality rates are reducing in Europe and U.S.A., while relatively, little attention has been paid to the magnitude of the problem in developing countries.

Bener and Jadaan (1990) found in their study that road injuries are becoming a public health epidemic in Saudi Arabia. Traffic Accidents are one of the major causes of death in Saudi Arabia. Approximately 10% of the total deaths are because of traffic accidents (see Statistical Year Book 2000). Yet relative to other causes of mortality and morbidity , the amount of attention they have received from public health professionals and the scientific community is minuscule. Asogwa, (1998); and Langley and McLoughlin (1989) also agreed with this situation and reported it to be partly due to the absence of comprehensive documentation of the situation.

In Saudi Arabia, local customs restrict female teachers from driving. Female working in Saudi Arabia relies heavily on their spouse or a transportation establishment for mobility. Female teachers working on the outskirts of a city travel significantly on a daily basis. This is due to the large area of the kingdom and the long distances between cities.

The transportation system consists of three elements: the environment (roads) , vehicles; and people (drivers and pedestrians). As the information processor in the system. the driver's role is to process mostly visual inputs from the road, traffic and his or her car's behavior, make decisions about appropriate control action, execute these actions and observe and respond to the new situation that results. It is believed that drivers are the main contributors to accidents [see Pignataro (1973).]

Inappropriate driving behavior can result in unsafe driving conditions and increased accident potential. Such behavior could result from ignorance, apathy, impatience, thrill seeking, or the desire to save time. Driving is a skill that is learned, and judgment comes only with experience, so that it would seem self-evident that the inexperienced driver would be at greater risk. Also those who drive higher mileages or

have driven longer are more exposed to risk and might be expected to commit more motoring offenses, and these violations may lead to accidents (see Shaw Lynette 1971a).

Table 1.1 shows a comparison of traffic accident statistics between Saudi Arabia and other countries (see Abdullah 2000).

Table 1.1: Comparison of Traffic Accident Statistics between Saudi Arabia and Other Countries

Country	Traffic Accident Related Deaths	Deaths per 100,000 persons	Deaths per 100,000 vehicles
Sweden	537	6.1	13.5
United Kingdom	3598	6.3	12.8
Holland	1180	7.6	18.5
Finland	404	7.9	18.3
Switzerland	616	8.7	16.2
Japan	11674	9.3	17.4
Bahrain	57	9.5	32.6
Canada	3082	10.3	18.5
Germany	8758	10.7	20.2
Australia	1973	10.8	17.6
Ireland	453	12.6	40.4
Austria	1027	12.7	25.6
France	8541	14.7	27.8
United States	41907	15.8	20.8
Luxembourg	68	17	26.8
Saudi Arabia	3123	17	62.4
Thailand	15000	25	125

1.2 Problem Statement

Victims of road traffic accidents and the resulting casualties are continuously increasing. In Saudi Arabia, traffic accidents are among the major causes of death, particularly for the female teachers' traveler group. The local newspapers constantly show news about female teachers' accidents and hold discussions about this topic. The new graduating female teachers do not have vacant positions in the inner city due to the fact the positions in the large cities are taken by older teachers. The new teachers have to travel outside the city to get a job opportunity. Local customs and culture forbid females from driving to work. They depend on drivers (their spouse or any other male driver) to reach their work. Many of them travel long distances to work. They use different means of transport (passenger car, taxi, bus, a group of teachers traveling together using van, suburban , bus , or hiring a driver or spouse of one of the teachers). They start their journey early at dawn (before sunlight) in order to travel the long distance and they return at the end of the day exhausted. Some of them travel hundreds of kilometers before reaching their destination.

It is vital to find the potential factors which are involved in creation of accidents in the female teachers' travelers group. The traffic police have no record regarding the female teachers traveling group. The possible causes include the driver, vehicle characteristics, and environment. The order of significance of interactions between the accident causing factors (passenger , driver, road and environment) is required in order to assess the actual situation.

Determination of the interaction between such factors as nationality , age , etc. is vital. This will help in assessing the most important and interacting factors and filtering

out the least important. This will help in providing viable recommendations to the female teachers group.

Female Teachers accidents during their rural work trips is of growing concern to both the people in the government and the general public.

1.3 Goals and Objectives

The main goal of this research is to determine the causes of accidents faced by the female teachers working in rural areas in the Kingdom of Saudi Arabia.

To achieve this goal, a number of objectives were identified which are summarized below:

1. To find out the principal causes of female teacher road traffic accidents.
2. To analyze and determine the interactions between accidents in the last 3 years and principal factors of female teachers attributes using different statistical methods, including log linear model.
3. To make recommendations for the improvement of driving safety based upon the above findings.

1.4 Research Hypotheses

It is hypothesized that there is a significant relationship between the human and vehicular interface. The following summarizes the Null hypotheses (Ho) for accident and the cause interactions.

Ho: There is a relation between the extent of traffic accidents in the last three years during female teachers rural work trips and:

- The Province in which the accident occurred
- Drivers' Nationality
- Drivers' Age
- Drivers' Performance
- Vehicle Manufacturer
- Vehicle Condition
- Relation of female teacher to driver
- Driver ownership of vehicle
- Mode of transportation
- Transportation establishment chosen by the teacher
- The distance traveled by the teacher
- The time spent traveling

The following summarizes the Null hypotheses (Ho) for the driver performance and factors affecting it:

Ho: There is a relation between the performance of the driver of the vehicle in which the female teacher is traveling and

- The age of the driver.

- Condition of the vehicle
- Nationality of the driver
- Driver vehicle ownership
- Teachers' relation to the driver

Chapter 2

LITERATURE REVIEW

2.1. Overview

Accident information is required for a variety of safety activities. This information assists in identification of safety problems, establishment of priority locations for safety improvements, and evaluation of specific accident countermeasures.

2.2. The Network of Accident Causation

Traffic accident can be attributed to human, vehicular and environmental factors. Sabey and Staughton (1975) concluded that human factors are present in about 95 % of accidents and are the sole contributor in accident causation 65% of the time.

Ergun (1988) investigated the safety problems in Saudi Arabia. He found that when considered alone, human factors account for about 57% and when together with other factors, (vehicle and environment) about 92% of automobile accidents.

The prominence given to the human factor in accident research in no way negates the importance of the many other factors, which can affect accident potential. In fact, major researchers like Eysenck (1965) have stressed the *multiplicity* of accident causes .

The human factor is of vital importance in the way it overrides the other interacting variables. The following are the different factors, which can affect accident potential in terms of their *inter-relationship* and in terms of their *practical implications.*

2.2.1 Exposure

A study by the Casualty Actuarial Society (CAS) in 1996 concluded that increased mileage increased crash risk. Even a "perfect" driver faces risks from causes beyond his control – an animal running into the roadway, catastrophic mechanical failure, and a heart attack – risks that increase with mileage. Wolfe. (1982) concluded that exposure to the risk of a road traffic accident is a concept, which has been frequently talked about in road safety research, and fortunately there have not been great divergences in opinion as to its basic meaning. It is a measure of the opportunities for an accident to occur. Measure of risk exposure is essential for a comprehensive analysis of factors related to highway accidents [See for example ChipMan and MacGregor 1990; Rochon, Swain, and O'Hara 1978]. There is also a general agreement on the understanding of the exposure concept concerning the road usage frequency and types of encountered situations [see Rochon et al., 1978.]

Chapman (1972) points out the way of viewing exposure to the risk of accidents in the road traffic network. One can seek to determine exposure and accident rates for the vehicle or road user as they move along in the system. Distance traveled seems generally the most appropriate exposure measure. However, other exposure measures sometimes suggested include: duration of travel, number of discrete trips, and number of road crossings.

Inherent in the concept of exposure is the idea of using exposure data to determine accident rates which indicate the relative degree of risk or danger of various road traffic situations (defining "situation" broadly to include all relevant vehicle, person, and environmental characteristics) [see Chapman (1972).]

Several measures of exposure (traffic volume ADT, number of trips, number of registered vehicles, number of licensed drivers, driving time, passenger miles, vehicle miles, occurrence of traffic conflicts, fuel consumption) have been proposed and successfully used in specific situations. However, the most common and the one used in vehicle miles of travel (VMT) (see White, 1976). Bener et al (1990) also recommended vehicle miles of travel as the most meaningful property for making comparisons

2.2.2 Effect of Driver's Age

Age was found to be a major contributor to accident involvement; Forbes (1972) mentioned that accidents and convictions for traffic offenses generally decrease with increasing age. However, when miles driven are taken into account, both young and old drivers have poorer driving records than do the middle age group.

Calvin (1993) concluded that young drivers are severely over represented in traffic crashes. Drivers with ages 16 & 17 have more than twice the average number of crashes in their first year of driving and four times as many crashes per mile driven as experienced adult drivers. Teenage drivers are two and half times more likely than the average driver to be in a fatal crash in which they have been drinking. They are twice as likely to be in a fatal crash as an average driver. Authorities attribute the driving problems of young drivers to the following:

1. Driving inexperience and lack of adequate driving skills
2. Excessive driving during high-risk hours, especially nighttime.
3. Risk taking behavior
4. Poor driving judgment and decision making.

Spolander (1983) argues that the young male driver has the best vision, the quickest reactions and often the best driving skill of all drivers and he knows it. However, he also has a reputation for having the worst accident figures of all driver groups. Why? It is not an effect of not knowing where the difficulties in traffic are. This seems to be fairly independent of the driver experience. Spolander concludes that it is probably because he underestimates the difficulties or overestimates his own capacity, or both. This results in very aggressive driving.

2.2.3 Vision

Accident causation is significantly influenced by the vision of the driver. Defective vision is possibly one of the most important (and *neglected*) of all the factors contributing to potential accidents, if only for the reason that so many people are affected by it. For although it is possible to compensate to a certain degree for poor vision by more careful driving, or by techniques like screwing up one's eye to get a better focus, the danger is obvious and fatigue inevitable [see Shaw (1971a).]

2.2.4 Intelligence

Shaw (1971a) concluded that there seems to have been some rather circumscribed thinking on the relationship between accidents and intelligence of the driver. A moron or

an imbecile is obviously incapable of handling a vehicle in modern traffic, and the sooner he is spotted the better.

Shaw also found that the effect which superior intelligence can exert on accident potential is also of vital concern. Here it is only to be expected that superior intelligence is not necessarily an asset and may even be a liability. Some one with a very active mind would find full-time driving rather monotonous, which could easily result in inattention or even frustration. It is very apparent that adequate intelligence is not anything like sufficient to ensure safe driving, as personality defects can provide the impetus for the most irrational driving behavior. Also a lower than average level of intelligence cannot accentuate these defects.

Shaw warned that it is dangerous enough for a driver's behavior to be motivated by *Selfishness, Exhibitionism or Irritability,* it is doubly dangerous when he lacks the intelligence to assess the possible consequences of his actions or is unable to think quickly and decisively in a crisis.

2.2.5 Risk Taking Behavior

" Bad accident risks" are frequently unstable, immature, aggressive, anti-social , self – centered and over confident, as well as being sometimes inadequate and insecure. " The good risks" are stable, conformist, and passive, and even submissive. Attitudes towards the taking of risks and danger seem to vary according to age and sex, with young men the most willing to take risks [see Shaw (1971b).]

D.L. Smith et al. (1998) studied the attitudes of high school students and found that those students who are most favorably disposed towards " taking chances" are about four

times more likely to have had more than one accident in the past year than those who are most opposed (26.9% vs. 6.2%). Similarly, students who find it thrilling to ride in a fast car are also more likely to have suffered accidental injury than those who do not have these attitudes.

2.2.6 Fatigue

Toaka (1993) explained that driver fatigue is a major contributor to accident potential. Drivers on a highway traveling a significant of distance on a daily basis face a monotonous environment and hence can create possible traffic accident causation potential. Falling asleep while driving is the most extreme end result of fatigue. Driving may not require excessive muscular work, but it does require mental work. There is only one successful way to overcome the effect of fatigue, and that is to take a nap. When this is unrealistic, the driver can energize himself or herself, by continuously shifting his or her eyes from one side of the road to other, by chewing gum, by singing, by opening a window to let fresh air come in, and the like. Toaka summarized the results of three studies and stated that approximately 20% of all drivers have either been involved in or have narrowly missed being involved in a traffic accident caused by drowsiness or falling asleep at the wheel.

2.2.7 Vehicle Condition

Another major factor contributing to the traffic death toll is the state of repair of vehicles in use on the highway. It is evident that brake failure while a vehicle is in motion almost invariably result in a crash. Thygerson (1977) reported that current crash

investigation often tends to over look or understate the role played by vehicle factors in causing crashes and casualties, since most investigations focus on the legal aspects of human fault. In some cases, the extent of the damage misleads investigators to think that a defect (if discovered at all) is the result of the crash rather than its cause. It is concluded that much, if not most, of the crash causation associated with the condition of vehicles is not being identified and reported.

2.3 Comparison of statistical techniques for accident analysis

There are a considerable number of statistical techniques with many variations that are used to analyze traffic accidents (e.g. descriptive statistics, correlation, etc.). A detailed description of the techniques used for the thesis is presented in upcoming chapters. The choice made here for comparison is restricted to linear models and generalizations of these models. Within this class those are selected that are frequently used for the analysis of accidents [see Tabachnick et al., 2001].

Tabachnick states that the popularity of linear models is primarily due to their statistical advantages. The parameters of linear models are linear transformations of the observed values. The mean values and variances of linear transformation, as well as test statistics and error boundaries of parameter values, are easily derived from the means and variances of the observations. However, these statistical advantages, as such, cannot justify application of these models to the data. If the data structure differs from the linear model, then nicely defined statistics are of no use. The tenability of the use of (generalized) linear models for accident analysis will be treated here. Therefore, a short discussion on the assumptions for applying these models will be given.

Tabachnick et al. further explained that object oriented techniques are techniques that have a particular object as unit of analysis. This object may be an accident, an accident location, a road user, for example. Design-oriented techniques do not work with the objects themselves, but with (combinations of) characteristics of objects, such as the class of young road users driving at night or during the daytime, or accident classifications according to age and sex. With design oriented techniques one is concerned with the classes of potential objects according to some classification principle and not with the measured objects themselves. The term is used, because this approach is generally applied in experimental designs, where objects are assigned to experimental or control conditions.

Another factor that remains implicit in most methodological discussions is the basic assumption for applying the model. Many applications of the linear model are based more on the nice statistical characteristics of the linear model than on the structure of the data to which the model has been applied; e.g. a log-transform on the dependent variable, to correct for non-normality, may justify the application of certain tests, but has a dramatic impact on the model assumptions with regard to the data structure [see Tabachnick (2001)]. We have used the Log-Linear Analysis method for our work.

Chapter 3

RESEARCH METHODOLOGY

This study focuses on the causes of female teachers' traveler group accidents. The police records do not have any data regarding the occupants of the accident vehicle whether they are female or not. The data used here was obtained from a nationwide study [see Al-Ahmadi et al (2002).] This study was designed mainly to analyze the causes of female teachers' accidents and analyze relationships between the human – vehicle interface. To achieve the goals and objectives of this research , certain *apriori* hypotheses were set and these were later on tested. To achieve the stated objective, we divided the research into stages as illustrated in fig 3.1.

3.1 Variable development

After several iterative rounds of targeted solutions' retrieval, several sets of variables were formulated.

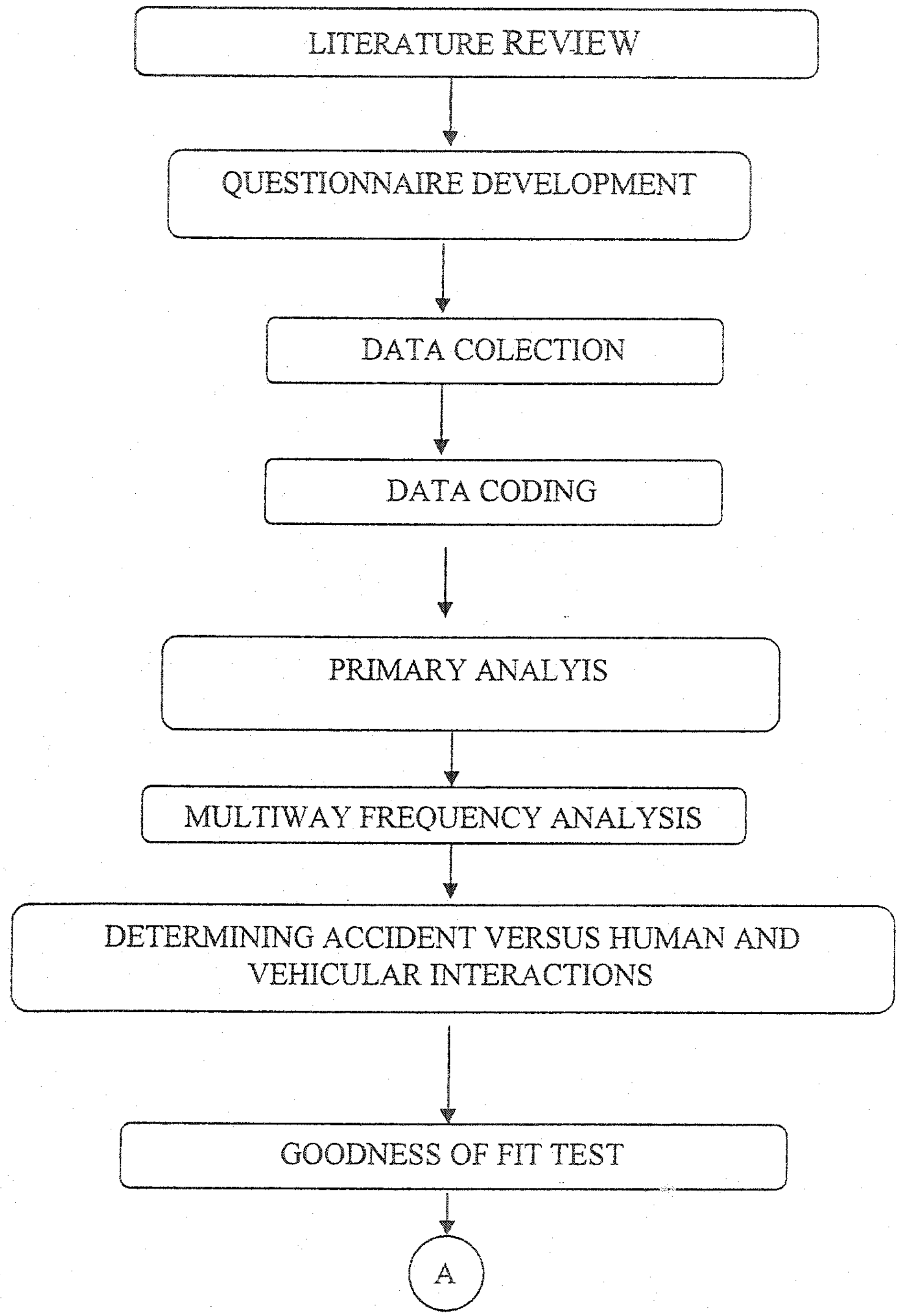

Fig 3.1: Research methodology

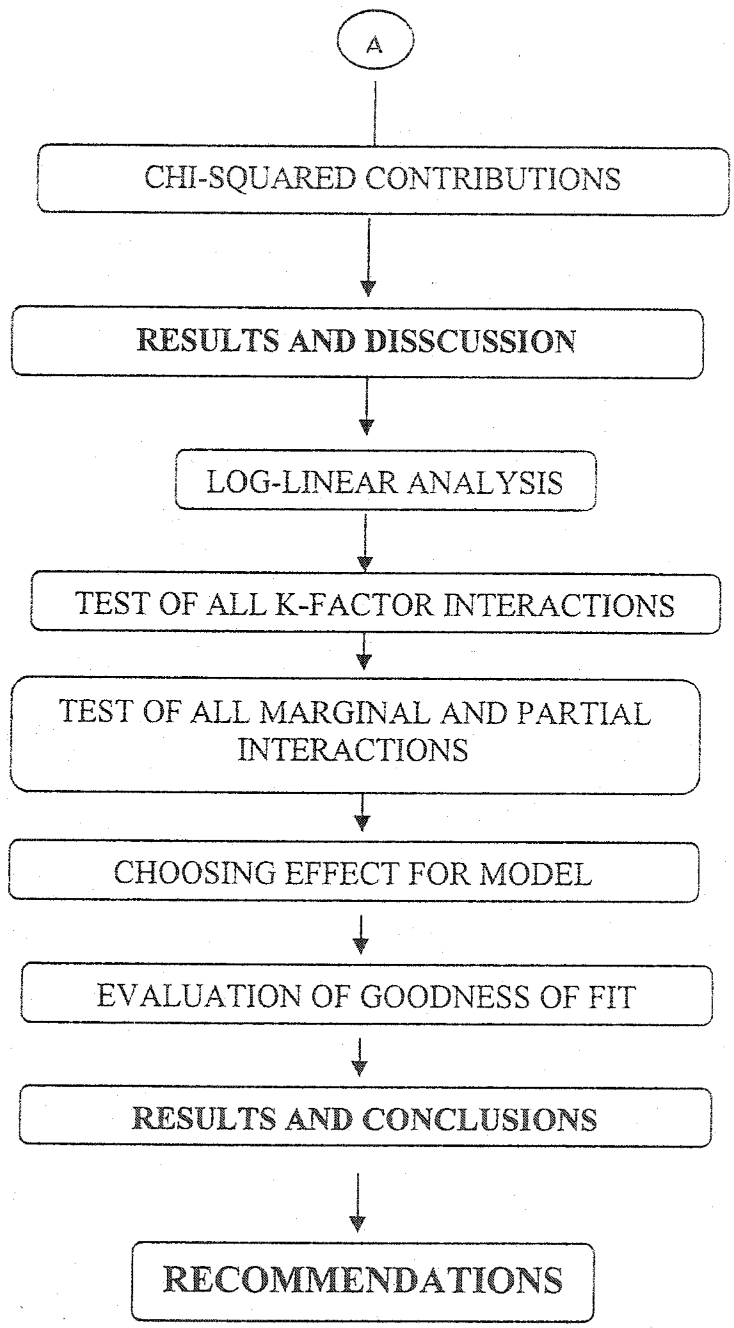

Fig 3.1: Research methodology (cont.)

3.1.1 Identification variables

Several identification variables were incorporated in order to recognize the relevant questionnaire and its properties. They include questionnaire ID, school type, branch code and province code.

3.1.2 Personal variables

These include marital status, number of years in the job in the same school. and total number of years in service.

3.1.3 Transportation variables

These include: mode of transportation, owner of the means of transport, teacher's relation to the driver, driver nationality, driver age, driver performance, vehicle manufacturer, vehicle model year, general condition of vehicle, teachers having other mode choice option or not, number of teachers in vehicle, teacher's reason for current mode choice, driver's ownership of vehicle.

3.1.4Advanced transportation variables

The following variables are considered important in many studies so they need to be collected by the survey. They include travel cost , travel time , travel distance.

3.1.5 Accident information variables

Accident information variables were subdivided into four sections, namely:

1. Causes related to vehicle
2. Causes related to driver
3. Causes due to bad weather and road conditions.
4. Other causes

Causes related to vehicle

This variable includes an input related to tire failure, steering arms, lights, brakes, fire in vehicle , age of vehicle and other causes.

Causes related to driver

This variable includes an input for speeding , obedience to traffic laws, reckless driving , crossing at red lights, falling asleep , and other reasons.

Causes due to bad weather and road conditions

This includes an input for road conditions and weather as a cause of an accident.

Other causes

This section includes an input for the causes by other vehicles , animals crossing the road , pedestrian crossing the road, and other inputs.

3.2 Statistical Preliminaries

3.2.1 Introduction

Data arising from the summaries of surveys or results of questionnaires needs very careful analysis. This data consists of counts of people, places, or things (for our case: number of accidents, type of vehicle, etc) which have various combinations of characteristics.

3.2.2 Cross Tabulation

Cross tabulation refers in succinct form as shown in table 3.1

Table 3.1 : Simple example of cross tabulation

Driver	Occurrence of accident in last 3 years		
	No	Yes	Total
Spouse	324	84	408
Other	414	185	599
Total	738	269	1007

Table 3.1 can be referred to as two halves or two sub-tables. Each sub-table involves two criteria, for this reason it is referred to as a two-way table. Alternatively, the sub-table is easily written in two dimensions and consists of an array of numbers; it may also be referred to as a two-dimensional array or two dimensional table.

3.2.3 Chi-squared distribution

A probability distribution of paramount importance in the study of cross-classified data is the chi-squared distribution. The Chi squared test of independence is used to examine the relationship between two discrete variables. In X^2 analysis, the null hypothesis generates frequencies against which observed frequencies are tested. If the observed frequencies are similar to the expected frequencies, then the value of X^2 is small and the null hypothesis is retained; if they are sufficiently different then the value of X^2 is large and the null hypothesis is rejected. A detailed discussion of the null hypothesis is presented in the following paragraphs [see Tabachnick (2001).]

A hypothesis is making a suggestion concerning possible mathematical descriptions of the interrelation present in the data [see Plackett (1981).] The most familiar of the hypotheses concerning a set of data is that the characteristics concerned (e.g. accidents and driver performance) are unrelated to one another; this is the hypothesis of mutual Independence or primary hypothesis or Null hypothesis.

To test the significance, or otherwise, of a hypothesis, we need to contrast it with some alternative hypothesis, which for the cases that we shall consider can be simply stated as "the null hypothesis is not true". To test the credibility assume that the null hypothesis is true. With this assumption, calculate the probabilities associated with the possible values of some appropriate combination, of test statistics, of the numbers under scrutiny. If the actual value of the test statistics is unusual, then either we have chanced upon an unusual occurrence or the original assumption (the null hypothesis) is incorrect [see Plackett (1981).]

In 1904 Pearson suggested and showed the test statistics, denoted by X^2 (the quantity X^2 is referred to as the Pearson chi-squared test) [See Graham (1977).]

$$X^2 = \sum_i \sum_j \frac{(f_{ij} - e_{ij})^2}{e_{ij}} \qquad (3.1)$$

where $i = 1,2,\ldots\ldots k$ (k= number of rows)

$j = 1,2,\ldots\ldots l$ (l = number of columns)

f_{ij} = observed values

e_{ij} = expected values

Provided none of the expected values were very small, the distribution of X^2 is approximately chi-squared. Graham (1977) said that the degrees of freedom of the chi-squared distribution are given by calculating the value "d",

$$d = \text{(number of cells)- (number of constraints implied by the data)} \qquad (3.2)$$

Another measure is the Likelihood Ratio Chi-squared Test which arises from comparing the estimated joint probability of occurrence of the data under the conditions specified by the null hypothesis with the corresponding probability for the alternative hypothesis [see Graham (1977).]

$$Y^2 = 2 \sum_i \sum_j \ f_{ij} \ln\left(\frac{f_{ij}}{e_{ij}}\right) \tag{3.3}$$

An estimated joint probability of this type is called a likelihood, and equation (3.3) represents a ratio of two likelihoods. Since Y^2 turns also to have an approximate X^2 distribution , with the same degree of freedom as X^2 , Y^2 is sometime referred to as the *likelihood ratio chi-squared* [see Graham (1977).]

3.3 Association and independence in 2 X 2 tables

3.3.1 Observed frequency

The data collected for surveys are typically done either by interview or by questionnaire. All these data can be compactly coded and entered in a computer. The usual practice of handling large amounts of data involves studying two variables at a time, each with two levels, in an effort to determine the association between them. We need an association to filter out the potentially important factors and hence find the best interaction model. Table 3.2 shows the frequency table for a 2 X 2 table.

Graham showed that if A and B are independent, then

$$\frac{f_{11}}{f_{01}} = \frac{f_{12}}{f_{02}} \tag{3.4}$$

also

$$\frac{f_{11}}{f_{10}} = \frac{f_{21}}{f_{20}} \tag{3.5}$$

where f_{ij} = The observed frequency of the respondents of category (A_i, B_j)

3.3.2 Probability

Let p_{ij} be the theoretical probability of a randomly chosen respondent belonging to cell (i,j) , that is to be categories A_i and B_j. We can represent the p_{ij} as in table 3.3

So that

$$p_{0j} = \sum_i p_{ij} \tag{3.6}$$

$$p_{i0} = \sum_j p_{ij} \tag{3.7}$$

and

$$p_{00} = \sum_i \sum_j p_{ij} = 1 \tag{3.8}$$

If A and B are independent then

$$p_{ij} = p_{i0}\, p_{0j} \qquad i,j = 1,2 \tag{3.9}$$

Simplifying and cross-multiplying we get

$$\frac{p_{11}p_{22}}{p_{12}p_{21}} = 1 \tag{3.10}$$

where p_{ij} = The theoretical probability of a randomly chosen respondent belonging to cell (i,j), that is to categories A_i and B_j

3.3.3 Expected frequency

If A and B are independent, and we have a total of f_{00} observations in the table then expected cell frequency in the (i,j) cell will be

$$e_{ij} = \frac{f_{i0} f_{0j}}{f_{00}} \tag{3.11}$$

The comparison of the expected frequency e_{ij} , which assumes independence, and the observed frequency f_{ij} will provide a basis for a test of the assumption of independence.

Table 3.2 Frequency Table for 2x 2 data

	B_1	B_2	Total
A_1	f_{11}	f_{12}	f_{10}
A_2	f_{21}	f_{22}	f_{20}
Total	f_{01}	f_{02}	f_{00}

Table 3.3 : Theoretical probability distribution for2 x 2 data

	Variable B		
Variable A	B_1	B_2	Total
A_1	p_{11}	p_{12}	p_{10}
A_2	p_{21}	p_{22}	p_{20}
Total	p_{01}	p_{02}	p_{00}

3.3.4 Pearson chi-squared test for 2x 2 table

The magnitude of Interdependence between variables A and B manifested in the data is of vital concern [see Rencher (1998).] The simplest way is to look at the individual cell contribution to X^2 statistics. Table 3.4 illustrates the idea.

Table 3.4 : Contributions to chi-squared

Contributions to chi-squared			
	B1	NOT B1	Total
A1	13	47	60
NOT A1	7	**133**	**140**
Total	20	180	200

The Chi–Squared test is important for finding the potential relation between the discrete variables. The tests for goodness of fit based on X^2 are clearly applicable to this situation; since we are comparing observed and expected frequencies. The X^2 test takes the following simple form:

$$X^2 = \frac{f_{00}(f_{11}f_{22} - f_{12}f_{21})^2}{f_{10}f_{20}f_{01}f_{02}} \qquad (3.12)$$

3.4 Association and independence in I X J tables

Let us say that A and B are poly-tomies rather than dichotomies. Let I be possible categories for variable A, from $A_1, A_2, \ldots. A_I$, and J be possible categories for variable B, from $B_1, B_2, \ldots. B_J$. Table 3.5 shows the form of the I X J table.

Table 3.5: Observed Frequencies in I X J table

	B_1	B_2	B_j	B_J	Total
A_1	f_{11}	f_{12}	f_{1j}	f_{1J}	f_{10}
A_2	f_{21}	f_{22}	f_{2j}	f_{2J}	f_{20}
Ai	f_{i1}	f_{i2}	f_{ij}	.	.
.	.	.	.	.	.
A_I	f_{I1}	f_{I2}	.	f_{IJ}	f_{I0}
Total	f_{01}	f_{02}	.	f_{0J}	f_{00}

3.4.1 Measure of Association λ

Measure of Association provides a simple and quick quantification of the extent of independence between the variables [see Graham (1977).[Equation 3.13 shows the formula for calculating the measure of association λ

$$\lambda = \frac{(\sum_i^I f_{im} - f_{om}) + (\sum_i^J f_{mj} - f_{mo})}{2f_{oo} - f_{mo} - f_{om}} \quad (3.13)$$

where f_{mj} = Largest entry in the j^{th} column of the table

f_{mo} = Largest of the row marginal totals

f_{oo} = Total sum of the columns and rows

3.5 Association and independence in multidimensional tables

Relationships among three or more discrete (categorical, qualitative) variables are studied through multi-way frequency analysis or an extension of the log-linear analysis [see Tabachnick (2001).] Relationships between two discrete variables are studied through the two-way chi-square test of association. If a third variable is added, two- and three-way associations are sought through multi-way frequency analysis.

To do a multi-way frequency analysis, tables are formed that contain the one-way, two-way, three-way, and higher-order associations. A linear model of (the logarithm of) expected cell frequencies is developed. The log-linear model starts with all of the one-, two-, three-, and higher-way associations and then eliminates as many of them as possible, while still maintaining an adequate fit between expected and observed cell frequencies. Finally, there is a one-way test for each of the variables against the hypothesis that frequencies are equal in each cell (a test analogous to equal frequency goodness-of-fit tests in chi-square analysis) [see Tabachnick (2001).]

Chapter 4

DATA COLLECTION

4.1 Introduction

This section explains the data collection effort for the survey for the research. The design of the main survey instrument is presented.

4.2 Variable Construction and Pilot Survey

In any research, the questionnaire is of great importance for it has to yield the raw material for the research. Writing good survey questions is very difficult. Consequently, many surveys have questions with no feasible responses, questions with too many feasible responses, too many questions, vague instruction, and other flaws. The best sampling plan and the most exhaustive statistical analysis are meaningless unless valid and reliable responses are obtained from the persons sampled.

The first step is to specify the purpose of the measurement. A pool of variables was prepared. A literature survey, expert opinions, focus group meetings and common sense were used to generate this list of items. This process was difficult, and required several iterations before a reasonably satisfactory set of variables were obtained, the set

of variable was reviewed and tested by many people to ensure that no ambiguities were contained in the list. After rounds of review and analysis, a total of 49 variables were formulated. The final list of variables is listed in Table 4.1

4.3 Question Order and Type

A great deal of attention was paid to the placement of the questions in relation to other questions. Easier questions like age, and marital status were placed early in the survey to avoid discouraging respondents. The survey begins with an introduction, explaining who is conducting the survey, the purpose of the survey, the subject matter covered by the survey, and information on the respondent's right and privileges.

A closed question format, presenting a fixed set of alternate answers, was chosen for following reasons:

1. Answers to closed questions are ready for analysis.

2. Closed questions reduce the amount of writing required and save the time of both the respondents and the analyst.

Different forms of closed questions including "Yes or No" questions (common and simple to score) and checklist questions (provide respondents with a list of possible responses) were used. An effort was made to make the questions as short as possible: to use standard demographic questions and terms, to use simple words to make the questionnaire understandable to the least sophisticated respondent, Technical jargon and slang were avoided, Respondents sometimes misinterpret very simple terms, therefore terms were defined very carefully. Controversial, racial, ethnic, or otherwise biased languages were also avoided.

Table 4.1: List of Survey Variables

Number	VARIABLE
1	Type of school
2	Branch code
3	Province code
4	Marital status
5	Number of years in job in the current school
6	Total number of years in service
7	Use of the inter-city transport to reach work place
8	Is the city of residence the same as the city of work
9	Mode of transportation used
10	Owner of transportation mode in which the participant in the questionnaire survey is traveling.
11	Monthly cost of travel in Saudi Riyals
12	Relation to the driver
13	Nationality of the driver
14	Age of the driver of vehicle
15	Performance of the driver
16	Manufacturer of the vehicle
17	Model year of the vehicle
18	Availability of mode choice to participant in questionnaire survey
19	Number of participants in the vehicle, excluding participant in questionnaire survey
20	Travel time between home and school (one-way in minutes)
21	Travel distance from home to school (one way in kilometer)
22	Reason for current mode choice

Table 4.1: List of Survey Variables (cont.)	
23	Vehicle owned by the driver or not
24	Any traffic accidents experienced by participant in questionnaire survey in last 3 years?
25	Number of serious accidents while traveling to work experienced by participant
26	Number of minor injury accidents experienced by participant while going to work
27	Number of accidents without injury experienced by participant while going to work
28	Number of serious accidents experienced by participant while coming home from work
29	Number of minor injury accidents experienced by participant while coming home from work
30	Number of no injury accidents experienced by participant while coming home from work
31	Accidents caused by flat tire
32	Accidents caused by steering arms
33	Accidents caused by vehicle lights
34	Accident caused by fire in the vehicle
35	Accident caused by vehicle age
36	Accident caused by other vehicle errors, including collisions
37	Accident caused by driver's speeding
38	Accident caused by driver not obeying the traffic law
39	Accident caused by driver's reckless driving
40	Accident caused by driver crossing on red light
41	Accident caused by driver falling asleep
42	Accident caused by other drivers' errors, colliding with the vehicle in which the participant in the questionnaire survey is traveling

Table 4.1 List of Survey Variables (cont.)

43	Accident caused by bad weather while the participant in questionnaire survey is traveling.
44	Accident caused by bad roads while the participant in questionnaire survey is traveling.
45	Accident caused by other weather and road conditions
46	Accident caused by other vehicles' mistakes, colliding with the vehicle in which the participant in the questionnaire survey is traveling.
47	Accident caused by animal crossing the road, and colliding with the vehicle in which the participant in questionnaire survey is traveling.
48	Accident caused by pedestrian(s) crossing the road and colliding with the vehicle in which the participant in the questionnaire survey is traveling.
49	Accident caused by any other reasons

4.4 Final Form

By considering all the above points, the questionnaire was developed. The questionnaire was designed to collect information about the female teachers' attributes related to the above variables.

The questionnaire form consisted of the following.

1. Cover letter : The cover letter explained the purpose of the survey, its importance and confidentiality of responses.
2. Questions : Teachers were asked to evaluate the driver, and vehicle, along with their personal and traveling characteristics and details of any accidents experienced.

4.5 Sample Size

The sample size was calculated using the following formula:

$$n = \frac{p.q.k^2}{(e.p)^2} \qquad (4.1)$$

n = sample size required having an error of 25% and having a confidence level of 95%

p = the percentage of the population which had an accident during the last 3 years

q = the percentage of the population which did not have an accident during last 3 years

k = 1.96 at 95% confidence level

For p and q, accident data for the years 1419, 1420 , and 1421 were taken. The population in the year 1421 was found by extrapolating the population of 1412 with 3 % growth rate. The results are tabulated in Table 4.2 and Table 4.3.

Table 4.2 : Number of Accident during 1419-1421

Year	Number of accidents
1419	264,326
1420	276,772
1421	280,401
Total	821,499

Table 4.3 : Population of Saudi Arabia in 1412 and 1421

Year	Population
1412	16,948,388
1421	20,846,884

Accident statistics in the year 1418 show that there were 153,727 accidents and 291,779 people were involved in these accidents (1.9 persons per accidents). To be on the safe side, 2 persons per accident were assumed. A total of 2 X 821,499 means that 1,642,998 people were involved in accidents during the last 3 years.

$$p = \frac{1,642,499}{20,846,884} = 0.0788$$

Using the above statistics and Equation 4.1, the value of sample size required was found to be 719 questionnaires. More than 2400 questionnaires were distributed by post among female teachers working in the Kingdom of Saudi Arabia. A total of 64% of the questionnaires were returned. We rejected 28% of those received due to teachers not traveling between cities, which created an ambiguity. Finally, 1104 questionnaires were analyzed.

Chapter 5

DESCRIPTIVE STATISTICAL ANALYSIS OF SURVEY VARIABLES ATTRIBUTES

5.1. General

The female teachers' work trip accident study was analyzed statistically by descriptive statistics. Several measures were adopted, including the 95% confidence interval check, proportion and standard error.

5.2 Coding and Checking the Data

All the data were coded and checked for coding errors by collecting various statistics including: range, maximum, minimum and standard deviation. The absence of any out-of-range values indicated the absence of coding errors.

The STATISTICA package was used for checking the data for possible errors in data entry or coding. Different types of check were performed, as follows

5.2.1 Range check

Range checks were used to find out whether the value of a specific variable was exceeded. For instance, where a mode choice option question can only take "yes=1" or "no=2", other values are not valid.

5.2.2 More logical checks

Travel time should be consistent with cost relation. For instance as the travel cost increases, the time of travel should also be increased. This check resulted in filtering the biased or forged forms.

5.3 Analysis of Survey Variables

5.3.1 Type of School

Teachers were asked about the type of school they worked in. Table 5.1 depicts the descriptive statistics for type of school. The majority of our respondents are teaching in Primary schools, scoring 32.5% of the total and having a 95% confidence interval of 0.297 , 0.353.

5.3.2 Province

Table 5.2 depicts the descriptive statistics for province of the teachers. The majority of our respondents are teaching in the ASEER province scoring 19.3 % of the total, and having a 95% confidence interval of 0.170 , 0.217.

Table 5.1 Type of school

	No	Prop	SE	-95%CI	+95% CI
Primary	358	0.325	0.014	0.297	0.353
Intermediate	103	0.094	0.009	0.076	0.111
Secondary	77	0.070	0.008	0.055	0.085
Primary + Inter + second	171	0.155	0.011	0.133	0.177
Primary +Intermediate	217	0.197	0.012	0.173	0.221
Intermediate + Secondary	163	0.148	0.011	0.127	0.169
Others	0	0.000	0.000	0.000	0.000
No Answer	12	0.011	0.003	0.005	0.017
Total	1101	1.000			

Table 5.2 Province of respondent

	No	Prop	SE	-95%CI	+95% CI
ASEER	213	0.193	0.012	0.170	0.217
YANBU	44	0.040	0.006	0.028	0.052
AL-TAIF	131	0.119	0.010	0.099	0.138
AL-BAHA	134	0.122	0.010	0.102	0.141
AL-SHARKIAH	194	0.176	0.011	0.153	0.199
AL-QASEEM	83	0.075	0.008	0.059	0.091
TABOOQ	96	0.087	0.009	0.070	0.104
AL-MAJMAAH	51	0.046	0.006	0.034	0.059
JEEZAAN	155	0.140	0.012	0.116	0.166
No answer	0	0.000	0.000	0.000	0.000
Total	1101	1.000			

5.3.3 Marital status

Teachers were asked about their marital status and descriptive statistics of the marital status of the teachers traveling outside a city for their rural work trip were prepared. Table 5.3 depicts the descriptive statistics for marital status of the female teachers. The majority of our respondents are married, scoring 62.5 % of the total, and having a 95% confidence interval of 0.596 , 0.654. About 35 % were not married, having a 95% confidence interval of 0.328,0.386. About 2% of the respondent did not answer the question.

Table 5.3 : Marital Status of Female Teacher

	No	Prop	SE	-95%CI	+95% CI
Married	688	0.625	0.015	0.596	0.654
Not Married	393	0.357	0.014	0.328	0.386
No Answer	20	0.018	0.004	0.010	0.026
Total	1101	1.000			

5.3.4 Number of years in current school

Teachers were asked about the number of years they had been employed in their current school. Table 5.4 shows the descriptive statistics for number of employment years in their current school for female teachers. A total of 1020 teachers answered the question but 81 of them did not answer this question. The mean length of service of the female teachers was 3.79 years. There was a standard deviation of 3 years. The 95% confidence interval was found to be 3.61, 3.98.

Table 5.4 : Number of Years in Current school

	N	Mean	Std. Dev.	Standard Error	CV	Confid. -95.000%	Confid. +95.000%
	1020	3.79	3.04	0.095	0.80	3.61	3.98
No Answer	81						
Total	1101						

5.3.5 Number of years in service

Teachers were asked about their total number of employment years including their current school. Table 5.5 shows the descriptive statistics for total years in service of female teachers. A total of 996 teachers answered the question but 105 of them did not answer this question. The mean length of service of the female teacher was 5.23 years. There was a standard deviation of 4 years. The 95% confidence interval was found out to be 4.97, 5.49.

5.3.6 Mode of transportation

Teachers were asked about the mode of transportation which they use for traveling to their rural work. Table 5.6 depicts the descriptive statistics for mode of transportation, the majority of our respondents use the car as their mode of travel, scoring 48.2 % of the total, having a 95% confidence interval of (0.452, 0.512). Around 20% of the teachers use the suburban as their mode of travel, having a 95% confidence interval of (0.180, 0.229). A van is used by 19% of the teachers as their mode of travel, having a 95% confidence interval of 0.167,0.214. Around 6% of the females take a taxi as their mode of travel, having a confidence interval of 0.045,0.073.

Table 5.5 : Total number of Employment Years

	N	Mean	Std.Dev.	Standard Error	CV	Confid. -95.000%	Confid. +95.000%
	996	5.23	4.13	0.131	0.79	4.97	5.49
No Answer	105						
Total	1101						

Table 5.6 : Mode of Transportation

	No	Prop	SE	-95%CI	+95% CI
Passenger Car	531	0.482	0.015	0.452	0.512
Taxi	65	0.059	0.007	0.045	0.073
Van	210	0.191	0.012	0.167	0.214
Sub Urban	225	0.204	0.012	0.180	0.229
Big Bus	29	0.026	0.005	0.017	0.036
No Answer	41	0.037	0.006	0.026	0.049
Total	1101	1.000			

5.3.7 Owner of the means of transport

Teachers were asked about the owner of the transportation mode which they use for traveling to their work in rural areas. Table 5.7 depicts the descriptive statistics for owner of mode of transportation. The majority of owners are the spouse of the female teacher, scoring 41.8 % of the total, having a 95% confidence interval of (0.388, 0.448). Around 37% of the teachers use a government vehicle as mode of travel, having a 95% confidence interval of 0.345, 0.403. A company-owned vehicle is used by 9% of the teachers as their mode of travel, having a 95% confidence interval of 0.069, 0.102. Around 6% of the teachers did not answer the question.

Table 5.7 : Owner of the means of transport

	No	Prop	SE	-95%CI	+95% CI
Spouse	460	0.418	0.015	0.388	0.448
Company	94	0.085	0.008	0.069	0.102
Government	412	0.374	0.015	0.345	0.403
Others	66	0.060	0.007	0.046	0.074
No Answer	69	0.063	0.007	0.048	0.077
Total	1101	1.000			

5.3.8 Cost of travel (monthly in Saudi riyals)

Teachers were asked about their monthly cost of travel. Table 5.8 shows the descriptive statistics for monthly cost of travel. A total of 916 teachers answered the question and 185 of them did not answer this question. The mean monthly cost was found to be 681 riyals. There is a standard deviation of 400 riyals. The 95% confidence interval was found to be 655.25, 707.47.

Table 5.8 : Monthly cost of travel in Saudi riyals

	N	Mean	Std.Dev.	Standard Error	CV	Confid. -95.000%	Confid. +95.000%
	916	681.36	402.64	13.304	0.59	655.25	707.47
No Answer	185						
Total	1101						

5.3.9 Relation to the driver

Table 5.9 depicts the descriptive statistics for teacher relation to the driver. The majority of drivers are "others", scoring 56.1 % of the total, having a 95% confidence interval of 0.531, 0.591. Around 40% of the drivers are the spouses of female teachers, having a 95% confidence interval of 0.366, 0.425.

Table 5.9 : Teacher's relationship to driver

	No	Prop	SE	-95%CI	+95% CI
Spouse	435	0.395	0.015	0.366	0.425
Others	618	0.561	0.015	0.531	0.591
No Answer	48	0.044	0.006	0.031	0.056
Total	1101	1.000			

5.3.10 Driver Nationality

Teachers were asked about the nationality of the driver of vehicle which they use for traveling to their work. Table 5.10 depicts the descriptive statistics for driver nationality. The majority of drivers are Saudi, scoring 55 % of the total, having a 95% confidence interval of 0.520, 0.579. Around 7% of them were Asian.

Table 5.10 : Driver nationality

	No	Prop	SE	-95%CI	+95% CI
Saudi	605	0.550	0.015	0.520	0.579
Arab	37	0.034	0.005	0.023	0.044
Asian	72	0.065	0.007	0.050	0.080
Far East	23	0.021	0.004	0.012	0.030
Others	5	0.005	0.002	0.000	0.009
No Answer	359	0.326	0.014	0.298	0.354
Total	1101	1.000			

5.3.11 Driver Age

Teachers were asked about the age of the driver of the vehicle which they use for traveling to their work. Table 5.11 depicts the descriptive statistics for driver age. The majority of drivers are in the 30-40 age, scoring 32 % of the total, having a 95% confidence interval of 0.232, 0.285. Around 29% of them were in the 40-50 age range, giving a confidence interval of 0.264,0.319.

Table 5.11 : Driver age

	No	Prop	SE	-95%CI	+95% CI
< 30	174	0.158	0.011	0.136	0.180
30 – 40	321	0.292	0.014	0.264	0.319
40 – 50	285	0.259	0.013	0.232	0.285
50 – 60	216	0.196	0.012	0.172	0.220
> 60	63	0.057	0.007	0.043	0.071
No Answer	42	0.038	0.006	0.027	0.050
Total	1101	1.000			

5.3.12 Driver Performance

Teachers were asked about the performance of the driver of the vehicle which they use for traveling to their work. Table 5.12 depicts the descriptive statistics for driver performance. The majority of drivers are rated as excellent and good, scoring 40 % of the total, having a 95% confidence interval of 0.367, 0.426. Around 12% of them were in the acceptable rating, giving a confidence interval of 0.099,0.138.

Table 5.12 : Driver performance

	No	Prop	SE	-95%CI	+95% CI
Excellent	437	0.397	0.015	0.367	0.426
Good	437	0.397	0.015	0.367	0.426
Acceptable	130	0.118	0.010	0.099	0.138
Bad	34	0.031	0.005	0.020	0.041
Poor	27	0.025	0.005	0.015	0.034
No Answer	36	0.033	0.005	0.022	0.043
Total	1101	1.000			

5.3.13 Vehicle Manufacturer

Teachers were asked about the manufacturer of the vehicle that they use for traveling to work. The following is descriptive statistics regarding the manufacturer of the vehicles used by the teachers. Table 5.13 depicts the descriptive statistics for manufacturer of the teachers' vehicles. Thee majority of the vehicles were manufactured in Japan scoring 46 % of the total, having a 95% confidence interval of 0.433, 0.493. Around 30% of them were manufactured in the U.S.A., having a confidence interval of 0.276,0.331.

Table 5.13 : Vehicle Manufacturer

	No	Prop	SE	-95%CI	+95% CI
Japanese	510	0.463	0.015	0.433	0.493
American	334	0.303	0.014	0.276	0.331
Korean	22	0.020	0.004	0.012	0.028
European	21	0.019	0.004	0.011	0.027
Others	35	0.032	0.005	0.021	0.042
No Answer	179	0.163	0.011	0.140	0.185
Total	1101	1.000			

5.3.14 Vehicle Condition

Teachers were asked about the condition of the vehicle in which they traveled. Table 5.14 depicts the descriptive statistics for vehicle condition. The majority of the vehicles are rated to be in good condition, scoring 44 % of the total, having a 95% confidence interval of 0.412, 0.472. Around 26% of the vehicles were in excellent condition, giving a 95% confidence interval of 0.233,0.286.

Table 5.14 : Vehicle Condition

	No	Prop	SE	-95%CI	+95% CI
Excellent	286	0.260	0.013	0.233	0.286
Good	487	0.442	0.015	0.412	0.472
Acceptable	198	0.180	0.012	0.157	0.203
Bad	68	0.062	0.007	0.047	0.076
Poor	17	0.015	0.004	0.008	0.023
No Answer	45	0.041	0.006	0.029	0.053
Total	1101	1.000			

5.3.15 Teacher having mode choice option or not.

Teachers were asked about the availability of mode choice options (Any other mode then their current mode). Table 5.15 shows the descriptive statistics for mode choice option. The majority of the teachers do not have any other mode choice option, scoring 80% of total and giving a 95% confidence interval of 0.697, 0.751.

Table 5.15 : Availability of Mode Choice Options

	No	Prop	SE	-95%CI	+95% CI
Yes	130	0.118	0.010	0.099	0.138
No	797	0.724	0.013	0.697	0.751
No Answer	174	0.158	0.011	0.136	0.180
Total	1101	1.000			

5.3.16 Vehicle Occupancy

Teachers were asked about the number of teachers joining the vehicle. Table 5.16 shows the descriptive statistics for vehicle occupancy by female teachers. A total of 954 teachers answered the question and 147 of them did not answer this question. The mean occupancy was found to be five teachers. They have a standard deviation of 3.91. The 95% confidence interval was found to be 4.71, 5.20.

Table 5.16 : Vehicle Occupancy

	N	Mean	Std.Dev.	Standard Error	CV	Confid. -95.000%	Confid. +95.000 %
	954	4.95	3.91	0.127	0.79	4.71	5.20
No Answer	147						
Total	1101						

5.3.17 Travel time (one way in minutes)

Teachers were asked about the time it took to travel one-way to the work place. Table 5.17 shows the descriptive statistics for travel time of female teachers. A total of 1029 teachers answered the question but 72 of them did not answer this question. The mean travel time was found to be 62 minutes. They have a standard deviation of 45.93. The 95% confidence interval was found to be 58.70, 64.32.

Table 5.17 : Travel Time

	N	Mean	Std.Dev.	Standard Error	CV	Confid. -95.000%	Confid. +95.000%
	1029	61.51	45.93	1.432	0.75	58.70	64.32
No Answer	72						
Total	1101						

5.3.18 Travel Distance (one way in kilometers)

Teachers were asked about the travel distance each way to or from work. Table 5.18 shows the descriptive statistics for travel distance of the teachers in this survey. A total of 750 teachers answered the question but 351 of them did not answer this question. The mean travel distance was found to be 73 km. There was a standard deviation of 68.94. The 95% confidence interval was found out to be 68.05, 77.93.

Table 5.18 : Travel Distance

	N	Mean	Std.Dev.	Standard Error	CV	Confid. -95.000%	Confid. +95.000 %
	750	72.99	68.94	2.517	0.94	68.05	77.93
No Answer	351						
Total	1101						

5.3.19 Reason for Current Transportation Choice

Teachers were asked about the reasons for their current transportation vehicle choice. Table 5.19 depicts the descriptive statistics for reason for current mode choice option. A majority of the teachers do not have any other option, scoring 58% of the total, having a 95% confidence interval of 0.549, 0.608. Around 15% of them are using the current mode due to personal comfort, giving a confidence interval of 0.130,0.173.

Table 5.19 : Reason for Current Mode Choice Option

	No	Prop	SE	-95%CI	+95% CI
Security	93	0.084	0.008	0.068	0.101
Safety	31	0.028	0.005	0.018	0.038
Cost	12	0.011	0.003	0.005	0.017
No other Option	637	0.579	0.015	0.549	0.608
Personal Comfort	167	0.152	0.011	0.130	0.173
Others	5	0.005	0.002	0.000	0.009
No Answer	156	0.142	0.011	0.121	0.163
Total	1101	1.000			

5.3.20 Vehicle Ownership

Teachers were asked about the owner of the vehicle. Table 5.20 shows the descriptive statistics for vehicle ownership. A total of 878 of the drivers own the vehicle and 166 of them do not own it. The majority of drivers (about 80% of them) own the vehicle, giving a 95% confidence interval of 0.773, 0.822.

Table 5.20 : Vehicle ownership

	No	Prop	SE	-95%CI	+95% CI
Yes	878	0.797	0.012	0.773	0.822
No	166	0.151	0.011	0.129	0.172
No Answer	57	0.052	0.007	0.038	0.065
Total	1101	1.000			

5.3.21 Occurrence of Traffic Accidents

Teachers were asked about the occurrence of traffic accidents in the last 3 years. The following statistics show the occurrence of traffic accidents in the last 3 years. Table 5.21 shows the descriptive statistics for occurrence of traffic accident in the last 3 years. Around 25% of the teaches were involved in an accident during, the last 3 years, giving a 95% confidence interval of 0.225, 0.277.

Table 5.21 : Occurrence of Traffic Accident in Last 3 Years

	No	Prop	SE	-95%CI	+95% CI
Yes	276	0.251	0.013	0.225	0.277
No	756	0.687	0.014	0.659	0.715
No Answer	69	0.063	0.007	0.048	0.077
Total	1101	1.000			

5.3.22 Occurrence of Traffic Accidents While Going to School

Teachers were asked about the occurrence of traffic accidents in the last 3 years while they were going to school. It was noted that around 22% of the teachers had been involved in an accident during the last 3 years while going to their schools. Table 5.22 shows the descriptive statistics for the occurrence of traffic accidents on the way to school.

Table 5.22 : Occurrence of traffic accident while going to school

	No	Prop	SE	+95% CI	-95%CI
Major	19	0.017	0.004	0.025	0.009
Minor	48	0.044	0.006	0.056	0.031
No Injury	172	0.156	0.011	0.178	0.134
No Answer	862	0.783			
Total	1101	1.000			

5.3.23 Occurrence of Traffic Accident While Coming From School

Teachers were asked about the occurrence of traffic accidents in the last 3 years while they were coming from school. It was noted that around 16% of the teachers had been involved in an accident during the last 3 years while coming from school. Table 5.23 shows the descriptive statistics for the occurrence of traffic accidents while coming from school.

Table 5.23 : Existence of traffic accident while coming from school

	No	Prop	SE	-95%CI	+95% CI
Major	11	0.010	0.003	0.004	0.016
Minor	25	0.023	0.004	0.014	0.032
No Injury	138	0.125	0.010	0.105	0.145
No Answer	927	0.842			
Total	1101	1.000			

5.3.24 Causes of accidents

Table 5.24 shows that tyre failure, speeding, other vehicle problems and bad weather remain the major causes of road traffic accidents (RTAs). These scored 12.46 % , 11.02% , 13.05% and 11.02 % respectively. Vehicle error was the major cause of accidents scoring 30.78% of the total.

Table 5.24 : Accident Causes

Cause of accident		Number	% of Total	Total
Vehicle	Tire failure*	104*	12.46*	30.78*
	Steering	33	3.95	
	Lights	3	0.36	
	Brakes	33	3.95	
	Fire in vehicle	15	1.80	
	Vehicle age	46	5.51	
	Others	23	2.75	
Driver	Speed*	92*	11.02*	24.79
	Not obeying law	17	2.04	
	Reckless driving	44	5.27	
	Cross on red light	9	1.08	
	Fell asleep	28	3.35	
	Others	17	2.04	
Other	Other Vehicle Error*	109*	13.05*	24.55
	Animal crossing	59	7.07	
	Pedestrian crossing	24	2.87	
	Others	13	1.56	
Weather and Road	Bad weather*	92*	11.02*	19.88
	Bad road	62	7.43	
	Other	12	1.44	
	Total	835	100	

* highest

Chapter 6

STATISTICAL ACCIDENT ANALYSIS USING MULTI-WAY FREQUENCY TABLES

6.1 General Purpose and Description

The variables from the survey instrument were analyzed using the multi-way analysis technique. Relationships between the variables were sought. The data is discrete and for analysis of three or more discrete (categorical, qualitative) variables, multi-way frequency analysis is used. Relationships between two discrete variables are studied through the two-way chi-square test of association, if a third variable is added, two- and three-way associations are sought through multi-way frequency analysis. The purpose of multi-way frequency analysis (MFA) is used to discover associations among discrete variables. The set of two-way associations is then tested to see which associations might be not significant. *Occurrence of accident* and *Nationality* might be associated but *Nationality of driver* and *Marital Status of teacher* may not be associated. MFA helps in finding how well a model fits in observed frequencies. Tables 6.1 and 6.2 illustrate the list of analysis done for finding the interdependence between data.

Table 6.1 shows the result of interaction between accident in last three years and other variables.

Table 6.1 Occurrence of Accident and Interaction with Other Variables

	X^2	p	λ^*
Province	39.05	< 0.05	+
Driver nationality	10.12	0.04	+
Driver age	4.48	0.33	
Driver performance	57.18	< 0.05	-
Vehicle manufacturer	16.32	< 0.05	-
Condition of vehicle	32.72	< 0.05	-
Teacher relationship to driver	13.14	< 0.05	+
Reason for mode choice selection criterion	25.04	< 0.05	+
Vehicle ownership	6.09	< 0.05	+
Mode of transportation	7.00	< 0.05	
Transportation establishment chosen	19.10	< 0.05	+
Distance	23.06	< 0.05	+
Time	57.46	< 0.05	+

* sign calculated using λ

Table 6.2 shows the results of interaction with driver performance and factors affecting it.

Table 6.2 Interaction of Different Variables

	X^2	p	λ^*
Driver performance and driver age	60.32	< 0.05	+
Driver performance and vehicle condition	530.96	< 0.05	+
Driver performance and driver nationality	43.10	0.19	
Driver performance and vehicle ownership	72.27	< 0.05	+
Driver performance and teacher's relationship to driver	61.08	< 0.05	+

* sign calculated using λ

6.2 Accident Analysis

6.2.1 Interaction of the Province and Occurrence of Traffic Accidents in the Last 3 Years

The following statistics were revealed from the questionnaire survey done on a total of 1101 respondents. Some of the respondents did not answer various questions, hence the cross tabulation of the factors resulted in 1032 respondents. The interaction of the province and the existence of traffic accident in the last 3 years was sought. The comparison of the estimated frequency e_{ij}, which assumes independence and the observed frequency f_{ij} will provide a basis for a test of the assumption of independence. Table 6.3 shows the observed frequency for the interaction. A hypothesis was made about the independence of the province and the existence of traffic accidents in the last 3 years. The Null hypothesis of mutual independence is H_0 : There is no relation between the province and occurrence of traffic accidents in the last 3 years. The Alternate hypothesis H_1 goes : There exists a relation between province and existence of traffic accidents in the last 3 years.

The above hypothesis was tested on a 5 % significance level and the Pearson X^2 test was performed to determine the independence or dependence of the survey data. Table 6.4 shows the p-value (6.38E-06 < 0.05). Hence we can conclude that the province and occurrence of traffic accidents in the last 3 years are related.

Table 6.3 Observed Frequency (f_{ij}) of Interaction of Province and Existence of Traffic Accidents in the Last 3 Years

	No	Yes	Total
Asir	176	66	242
Yanbu	35	8	43
Al-Taif	85	59	144
Al-Baha	128	16	144
Al-Sharkiah	168	67	235
Al-Qassim	55	25	80
Tabuk	76	17	93
Al-Majmaah	33	18	51
Total	756	276	1032

Table 6.4 X^2 for Interaction of Province and Existence of Traffic Accident in the Last 3 Years

degrees of freedom d	Pearson chi-squared X^2	probability p
8	39.05247	6.38E-06

Since p-value is 6.38E-06 < 0.05, hence we can conclude that the province and existence of traffic accidents in the last 3 years are related. Table 6.5 shows the contributions for X^2. It was observed that

- Al-Baha province showed the highest inflation in the chi-squared value (8.88). The expected accidents in the last 3 years from our sample was 33. But there were only 16 accidents observed. This shows favorable safety conditions and a decrease in the province's accident rates.
- According to the statistical analysis, the second major source of inflation in X^2 values , as revealed , is Al-Taif. The expected accidents in last 3 years were 34 , but Al-Taif had 51 accidents, which is quite deviant from the expected accident rate. This shows a poor performance of traffic safety measures and increase in accident rates in the province.
- Another major contributor in the X^2 inflation is the province of Al-Sharkiah .The province had 59 accidents instead of the 50 expected. This shows a worse situation in terms of traffic safety in Al-Sharkiah.
- Yanbu and Tabuk experienced an improved situation in terms of traffic safety. The observed values were less than the expected accidents in the last 3 years. This shows favorable safety conditions and a decrease in the Province's accident rates.

Table 6.5 Contribution to X^2 values for Interaction of Province and Existence of Traffic Accidents in the Last 3 Years

	No	Yes	Total
Aseer	0.26	0.72	0.98
Yanbu	0.39	1.07	1.45
Al-Taif	3.00	8.21	11.21
Al-Baha	3.24	8.88	12.13
Al-Sharkiah	0.59	1.62	2.21
Al-Qassim	0.22	0.61	0.83
Tabuk	0.91	2.49	3.40
Al-Majmaah	0.51	1.39	1.90
Total	9.12	24.99	34.11

6.2.2 Interaction of Nationality of Driver and Occurrence of Traffic Accidents in the Last 3 Years

Table 6.6 shows the observed frequency from the questionnaire survey done for female teachers. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in only 717 respondents. Table 6.6 shows the observed frequency for the interaction of nationality and the occurrence of traffic accidents in the last 3 years.

The overall chi-squared (X^2) was found to be 10.13 having a p-value of 0.03186. Since the p-value, $0.038186 < 0.05$, hence we can conclude that nationality and the occurrence of traffic accidents in the last 3 years are related. Table 6.7 shows the contribution to chi-squared values for interaction of nationality and occurrence of traffic accidents in the last 3 years. It was concluded that

- Asians showed the highest inflation in the chi-squared value (3.23). The expected number of accidents in the last 3 years from our sample was 19, but 27 accidents were observed. This shows worsening safety conditions and Asians' poor compliance with traffic safety laws.
- According to the statistical analysis, the second major source of inflation in chi-squared values , as revealed , are Arabs. The expected number of accidents in the last 3 years was nine. Arab drivers had five accidents, which is quite deviant from the expected accident rate. This shows a good performance in traffic safety measures and compliance with traffic safety laws.

Table 6.6 Observed frequency (f_{ij}) for interaction of nationality and occurrence of traffic accidents in last 3 years

	Yes	No	Total
Saudi	434	154	588
Arab	29	5	34
Asian	43	27	70
Far East	15	10	25
Total	521	196	717

Table 6.7 Contribution to X^2 values for interaction of nationality and occurrence of traffic accidents in last 3 years

	No	Yes	Total
Saudi	0.11	0.28	0.39
Arab	0.75	1.98	2.73
Asian	1.22	3.23	4.45
Far East	0.70	1.86	2.56
Total	2.77	7.36	10.13

- Another major contributor in the X^2 are far east people. They had nine accidents instead of six expected. This shows a worse situation in terms of traffic safety and compliance with traffic laws.

- Saudis exhibited a good result in terms of traffic safety. They had only 154 accidents instead of the expected 160. The observed values were less than the expected accidents in the last 3 years. This shows good safety conditions and compliance with traffic laws.

6.2.3 Interaction of Driver Performance and Occurrence of Traffic Accidents in Last 3 Years

Driver performance is dependent on various factors, including driving exposure, driver's age, vision, intelligence, risk-taking behavior and fatigue. The driver's performance was evaluated by the female teachers riding in the vehicle and was scaled from excellent to poor on a scale of 1 to 5. Table 6.8 shows the observed frequency from the questionnaire survey. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1015 respondents. Table 6.8 shows the observed frequency for the interaction of driver performance and the occurrence of traffic accidents in the last 3 years.

The overall X^2 was found to be 57.18 having a p-value of 1.01E-11. Since the p-value is 1.01E-11 < 0.05, hence we can conclude that driver performance and occurrence of traffic accidents in the last 3 years are related. Table 6.9 shows the chi-squared contributions of each category. It can be concluded that:

- The drivers evaluated *bad* by the teachers showed the highest inflation in the chi-squared value (15.23). The expected accidents in the last 3 years from our sample was nine but they had 21 accidents.
- According to the statistical analysis, the second major source of inflation in chi-squared values, as shown, were the drivers evaluated as *excellent*. The expected number of accidents in the last 3 years was 112. They had only 73 accidents. This shows a good compliance to traffic safety laws from the drivers.

Table 6.8 Observed frequency (f_{ij}) of interaction of driver performance and occurrence of traffic accidents in the last 3 years

	No	Yes	Total
Excellent	343	73	416
Good	296	116	412
Acceptable	74	52	126
Bad	13	21	34
Poor	15	12	27
Total	741	274	1015

Table 6.9 Contribution to chi-squared values for interaction of driver performance and occurrence of traffic accidents in the last 3 years

	No	Yes	Total
Excellent	5.09	13.75	18.84
Good	0.08	0.21	0.28
Acceptable	3.52	9.51	13.03
Bad	5.63	15.23	20.86
Poor	1.13	3.05	4.17
Total	15.43	41.74	57.18

- Another major contributor in the X^2 were drivers evaluated as having *acceptable* performance. They had 52 accidents instead of the 34 expected. This shows a worse situation in terms of traffic laws compliance.
- Drivers evaluated *good* had 116 accidents instead of the expected 111. The observed values were greater than the expected accidents in the last 3 years. This shows poor compliance with the traffic laws.

6.2.4 Interaction of Vehicle Manufacturer and Occurrence of Traffic Accident in the Last 3 Years

Table 6.10 demonstrates the observed frequency for extracting the interaction of the vehicle manufacturer and occurrence of the accidents. Some of the teachers did not answer various questions, hence the cross-tabulation of the factors resulted in 917 respondents.

The overall X^2 was found to be 16.32, having a p-value of 0.004214. Since p-value is $0.004214 < 0.05$, hence we can conclude that the vehicle manufacturer and Occurrence of traffic accident in the last 3 years are related. Table 6.11 shows the X^2 contributions of each category. It was concluded that

- *Japanese* vehicles showed the highest inflation in the chi-squared value (7.57). The expected number of accidents in the last 3 years was 16, but they had only five accidents.
- According to the statistical analysis, the second major source of inflation in chi-squared values, as shown, were the *Korean* vehicles. The expected number of accidents in the last 3 years was 82. They had 98 accidents, which is quite deviant from the expected accident rate.

Table 6.10 Observed Frequency (f_{ij}) for Interaction of Vehicle Manufacturer and Occurrence of Traffic Accident in the Last 3 Years

	No	Yes	Total
Japanese	58	5	63
American	365	123	488
Korean	227	98	325
European	17	5	22
Others	17	2	19
Total	684	233	917

Table 6.11 Contribution to chi-squared values for interaction of vehicle manufacturer and occurrence of traffic accidents in last 3 years

	No	Yes	Total
Japanese	2.58	7.57	10.15
American	0.00	0.01	0.01
Korean	0.98	2.88	3.86
European	0.02	0.06	0.08
Others	0.56	1.66	2.22
Total	4.15	12.18	16.32

6.2.5 Interaction of Vehicle Condition and Occurrence of Traffic Accidents in the Last 3 Years

A major factor contributing to the traffic death toll is the state of repair of vehicles in use on the highway. Table 6.12 reveals the observed frequency for extracting the interaction of the vehicle condition and occurrence of the accident. Some of the teachers did not answer various questions, hence the cross-tabulation of the factors resulted in 1008 respondents.

The overall X^2 was found to be 32.72412 having a p-value of 1.5E-09. Since p-value is 1.5E-09 < 0.05 , hence we can conclude that the vehicle condition and occurrence of traffic accidents in the last 3 years are related. Table 6.13 shows the X^2 contributions of each category. It was found that:

- The vehicles in *excellent* condition showed the highest inflation in the chi-squared value (10.39). The expected accidents in the last 3 years were 73, but they had only 46 accidents, which show that vehicles in *excellent* condition experience fewer accidents than expected.
- According to the statistical analysis, the second major source of inflation in chi-squared values , as shown, were the vehicles in *acceptable* condition. The expected accidents in the last 3 years were 51. They had 73 accidents, which is quite deviant from the expected accident rate. This shows that vehicles in *acceptable* condition experience more accidents than expected.

Table 6.12 Observed frequency (f_{ij}) for interaction of vehicle condition and existence of traffic accident in last 3 years

	No	Yes	Total
Excellent	227	46	273
Good	341	121	462
Acceptable	116	73	189
Bad	41	26	67
Poor	11	6	17
Total	736	272	1008

Table 6.13 Contribution to chi-squared values for interaction of vehicle condition and existence of traffic accident in last 3 years

	No	Yes	Total
Excellent	3.84	10.39	14.23
Good	0.04	0.11	0.15
Acceptable	3.51	9.49	13.00
Bad	1.28	3.47	4.75
Poor	0.16	0.44	0.60
Total	8.83	23.89	32.72

- Vehicles in *good* condition had 121 accidents instead of 124 expected which showed an improved situation in terms of traffic safety.
- Vehicles in *bad* and *poor* conditions had even more accidents than expected.

6.2.6 Interaction of the Relationship to the Driver and Occurrence of Traffic Accident in the Last 3 Years

The driver's relationship to the female teachers was sought in the survey questionnaire and was categorized into *spouse* or *others* categories. Table 6.14 demonstrates the observed frequency for extracting the interaction of the teacher's relationship to the driver and occurrence of accidents. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1007 respondents.

The overall X^2 was found to be 13.143, having a p-value of 0.000303. Since p-value is 0.000303 < 0.05, hence we can conclude that the relationship to the driver and occurrence of traffic accident in last 3 years are related. Table 6.15 shows the X^2 contributions of each category. It was found that:

- The *spouse* showed the highest inflation in the chi-squared value (5.73). The expected accidents in the last 3 years were 108, but they had only 84 accidents, which show that *spouses* experienced fewer accidents than predicted by the model.
- According to the statistical analysis, the second major source of inflation in chi-squared values, as shown, were the *other* drivers. The expected number of accidents in the last 3 years was 160. They had 185 accidents, which is quite deviant from the expected accident rate. This shows *other* drivers experienced more accidents than expected.

Table 6.14 : Observed Frequency (f_{ij}) for Interaction of Relation to Driver and Occurrence of Traffic Accidents in the Last 3 Years

	No	Yes	Total
Spouse	324	84	408
Other	414	185	599
Total	738	269	1007

Table 6.15 : Contribution to X^2 values for Interaction of Relation to Driver and Occurrence of Traffic Accident in the Last 3 Years

	No	Yes	Total
Spouse	2.09	5.73	7.82
Other	1.42	3.90	5.33
Total	3.51	9.63	13.14

6.2.7 Interaction of the Reason for Current Mode choice Selection Criterion and Occurrence of Traffic Accident in the Last 3 Years

The reasons for the current mode choice selection were sought and categorized into the following: security, traffic safety, travel cost, no other choice, convenience, and others. Table 6.16 shows the observed frequency for the interaction of the reason for current mode choice and existence of the accident. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 903 respondents.

The overall X^2 was found to be 25.03811 having a p-value of 0.000225. Since p-value is $0.000225 < 0.05$, hence we can conclude that the reason for current mode choice and occurrence of traffic accidents in the last 3 years are related. Table 6.17 shows the X^2 contributions of each category. It was found that:

- The teachers choosing the current mode for the *convenience* showed the highest inflation in the chi-squared value (7.95). The expected number of accidents in the last

3 years was 42, but they had 24 accidents. This shows that the teachers choosing the mode with respect to their personal *convenience* were less involved in accidents.

- According to the statistical analysis, the second major source of inflation in chi-squared values , as shown , were teachers choosing the mode option since they have *no other option*. The expected accidents in the last 3 years were 162, but they had 192 accidents, which is quite deviant from the expected accident rate. This shows that the teachers choosing the mode since they had *no other option* were more involved in accidents.

Table 6.16 : Observed Frequency (f_{ij}) for Interaction of Reason for Current Mode Choice and Occurrence of Traffic Accident in the Last 3 Years

	No	Yes	Total
Security	67	16	83
Traffic safety	28	3	31
Cost	8	3	11
No other option	421	192	613
Convenience	136	24	160
Other	4	1	5
Total	664	239	903

Table 6.17: Contribution to chi-squared values for interaction of Reason for Current Mode Choice and Occurrence of Traffic Accidents in last 3 Years

	No	Yes	Total
Security	0.58	1.62	2.20
Traffic safety	1.19	3.30	4.49
Cost	0.00	0.00	0.00
No other option	1.96	5.46	7.42
Convenience	2.86	7.95	10.81
Other	0.03	0.08	0.11
Total	6.63	18.41	25.04

- The teachers choosing the mode because of *security, traffic safety,* and *other* reasons experienced more accidents than expected.

6.2.8 Interaction of Vehicle Ownership and Occurrence of Traffic Accidents in the Last 3 Years

The following statistics were obtained from the questionnaire survey done for a total of 1101 respondents. The interaction of vehicle ownership and occurrence of traffic accidents in the last 3 years was sought. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1002 respondents. Table 6.18 shows the observed frequency for the interaction.

The overall X^2 was found to be 6.093 having a p-value of 0.012705. Since p-value is $0.012705 < 0.05$, hence we can conclude that vehicle ownership and occurrence of

traffic accidents in the last 3 years are related. Table 6.19 shows the X^2 contributions of each category. It was found that

- The highest inflation in the chi-squared value (3.79) was contributed by the drivers who *do not own* the vehicle. The expected accidents in the last 3 years were 41, but they had 54 accidents. This shows that the drivers who *do not own* the vehicle are more involved in accidents.
- According to the statistical analysis, the *owner* of vehicle showed less inflation in X^2 values. The expected accidents in last 3 years were 221. They had 209 accidents, which differs from the expected accident rate. This shows a good adherence to traffic safety measures and compliance with traffic safety laws.

Table 6.18: Observed frequency (f_{ij}) for interaction of vehicle ownership and occurrence existence of traffic accidents in the last 3 years

Driver owner of vehicle	No	Yes	Total
Yes	635	209	844
No	104	54	158
Total	739	263	1002

Table 6.19: Contribution to X^2 values for interaction of Vehicle ownership and occurrence of traffic accident in the last 3 years

Driver owner of vehicle	No	Yes	Total
Yes	0.25	0.71	0.96
No	1.35	3.79	5.13
Total	1.60	4.49	6.09

6.2.9 Interaction of Mode of Transportation and Occurrence of Traffic Accidents in the Last 3 Years

The responses to the mode of transportation question were categorized into the following modes: passenger car, taxi, van, sub-urban and bus. The interaction of the mode of transportation and occurrence of traffic accidents in the last 3 years was sought. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1011 respondents. Table 6.20 shows the observed frequency for the interaction.

The overall X^2 was found to be 7.000 having a p-value of 0.00145. Since p-value is $0.00145 < 0.05$, hence we can conclude that the mode of transportation and existence of traffic accidents in the last 3 years are related. Table 6.21 shows the X^2 contributions of each category. It was found that:

- *Bus* showed the highest inflation in the chi-squared value (1.64). The expected accidents in last three years were seven but they had only four accidents. This show improving safety conditions and reduction in accident rates when we use *bus*.
- According to the statistical analysis the second major source of inflation in chi-squared values , as shown, is the *van* mode of travel. The expected accidents in the last three years were 54. They had 64 accidents, which is quite deviant from the expected accident rate. This show deteriorating safety conditions and an increase in accident rates when we use the *van* as a mode of travel.

Table 6.20 : Observed frequency (f_{ij}) for interaction of mode of transportation and occurrence of traffic accidents in the last 3 years

Mode of transport	No	Yes	Total
Passenger car	378	121	499
Taxi	41	16	57
Van	140	64	204
Suburban	157	66	223
Bus	24	4	28
Total	740	271	1011

Table 6.21 : Contribution to X^2 values for Interaction of Mode of Transportation Vehicle and Occurrence of Traffic Accidents in the last 3 Years

Mode of transport	No	Yes	Total
Passenger car	0.45	1.22	1.66
Taxi	0.01	0.03	0.05
Van	0.58	1.59	2.17
Suburban	0.24	0.65	0.89
Bus	0.60	1.64	2.24
Total	1.88	5.12	7.00

- Another major contributor in the X^2 inflation is *passenger car* mode of travel. They had 121 accidents instead of the 133 expected. This show improving safety conditions and reduction in accident rates when we use the *passenger car* mode of travel.
- *Taxis* and *sub-urban* exhibited a bad situation in terms of traffic safety. The observed values were greater than the expected accidents in the last 3 years. This show deteriorating safety conditions and an increase in accident rates when we use *taxi* and *sub urban* as a mode of travel.

6.2.10 Interaction of Transportation Establishment and Occurrence of Traffic Accident in the Last 3 Years

The responses to the question on transportation establishment were categorized into the following modes: spouse, company, self-employed, and others. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 982 respondents. Table 6.22 shows the observed frequency for the interaction.

The overall X^2 was found to be 19.1005 having a p-value of 0.000259. Since p-value is 0.000259 < 0.05, hence we can conclude that the transportation establishment and traffic accident in last 3 years are related. Table 6.23 shows the X^2 contributions of each category. It was found that:

- The major source of X^2 values , as shown, are *company* vehicles. The expected accidents in the last three years were 24. These vehicles had 37 accidents. which is quite deviant from the expected accident rate. This shows a poor performance in terms of traffic safety and compliance with traffic safety laws by the drivers of *company* vehicles.
- *"Spouse"* category showed the second highest inflation in the chi-squared value (4.95). The expected number of accidents in the last three years was 112, but they had only 89 accidents. This shows that *spouses* are more careful, which is only to be expected.

Table 6.22 : Observed frequency (f_{ij}) for interaction of transportation establishment and occurrence of traffic accidents in the last 3 years

Transport Establishment	No	Yes	Total
Spouse	338	89	427
Company	54	37	91
Self employed	282	119	401
Others	49	14	63
Total	723	259	982

Table 6.23 : Contribution to X^2 values for interaction of transportation establishment and occurrence of traffic accidents in the last 3 years

Transportation establishment	No	Yes	Total
Spouse	1.77	4.95	6.73
Company	2.52	7.04	9.56
Self employed	0.59	1.66	2.25
Others	0.15	0.41	0.56
Total	5.04	14.06	19.10

- *Self-employed* drivers also exhibited a bad performance and deteriorating situation in terms of traffic safety. They had 119 accidents instead of the expected 105. The observed values were greater than the expected number of accidents in the last three years.

6.2.11 Interaction of Travel Distance and Occurrence of Traffic Accident in the Last 3 Years

Even a "perfect" driver faces risks from causes beyond his control – for example, an animal running onto the roadway, catastrophic mechanical failure, a heart attack – that increase with mileage. The interaction between the accidents and the travel distance was sought from 1101 respondents. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in only 723 respondents. Table 6.24 shows the observed frequency for the interaction.

The overall X^2 was found to be 22.98848 having a p-value of 0.000803. Since p-value is $0.000803 < 0.05$, hence we can conclude that the travel distance and traffic accident in last 3 years are related. Table 6.25 shows the X^2 contributions of each category. It was found that:

- According to the statistical analysis the major source of inflation in chi-squared values , as shown, are teachers traveling less than 30 km . The expected number is accidents in the last three years were 61. They had only 37 accidents, which is quite deviant from the expected accident rate. This shows a good performance in terms of traffic

safety measures and compliance with traffic safety laws when the drivers travel less than 30 km.

- The drivers exposed more than 80 km also had high inflation in the chi-squared value (5.54). The expected accidents in the last three years were 68, but they had 88 accidents.
- The drivers who traveled more than 30 but less than 80 km registered small inflation in the chi-squared value (2.13).

Table 6.24 : Observed frequency (f_{ij}) for interaction of travel distance and occurrence of traffic accidents in the last 3 years

Travel distance	No	Yes	Total
<30	195	37	232
30-40	57	22	79
40-50	31	17	48
50-60	22	7	29
60-70	15	6	21
70-80	41	15	56
>80	170	88	258
Total	531	192	723

Table 6.25 : Contribution to X^2 values for interaction of travel distance and occurrence of traffic accidents in last 3 years

Travel distance	No	Yes	Total
<30	3.55	9.83	13.38
30-40	0.02	0.05	0.07
40-50	0.51	1.42	1.93
50-60	0.02	0.06	0.09
60-70	0.01	0.03	0.04
70-80	0.00	0.00	0.00
>80	2.00	5.54	7.55
Total	3.55	9.83	13.38

6.2.12 Interaction of Travel Time and Occurrence of Traffic Accident in the Last 3 Years

Driver fatigue is a major contributor to the potential for accidents. Drivers on a highway traveling a long time on a daily basis are faced with a monotonous environment and this can create a possible traffic accident hazard. The interaction between the accident occurrence and the travel time was sought from 1101 respondents. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 982 respondents. Table 6.26 shows the observed frequency for the interaction. The response of travel time was categorized into 15 min classes starting from < 30 min up to > 75 min.

The overall X^2 was found to be 57.27 having a p-value of 1.1115586E-11. Since p-value is 1.1115586E-11 < 0.05, hence we can conclude that travel time and traffic accidents in the last 3 years are related. Table 6.27 shows the X^2 contributions of each category. It was found that

- Drivers spending less than 30 min registered a high inflation in the chi-squared value (20.58). The expected accidents in last three years were 68 but they had only 31 accidents. This was expected since the driver is exposed to less time on the road.

Table 6.26 : Observed frequency (f_{ij}) for interaction of travel time and occurrence of traffic accidents in last 3 years

Travel time	No	Yes	Total
<30	232	31	263
30-45	170	53	223
45-60	114	40	154
60-75	20	17	37
>75	190	115	305
Total	726	256	982

Table 6.27: Contribution to X^2 values for interaction of travel time and Occurrence of traffic accidents in the last 3 years

Travel time	No	Yes	Total
<30	7.26	20.58	27.83
30-45	0.16	0.45	0.61
45-60	0.00	0.00	0.00
60-75	1.98	5.61	7.58
>75	5.59	15.84	21.43
Total	14.98	42.48	57.46

- According to the statistical analysis, another major source of inflation in chi-squared values, as shown is drivers, traveling for more than 75 min. The expected accidents in last three years were 79. They had 115 accidents. This is quite deviant from the expected number.
- Another contributor in the X^2 inflation is in the category of drivers traveling 60 to 75 min. They had 17 accidents instead of the nine expected.

6.3 ASSORTED INTERACTIONS BETWEEN OTHER VARIABLES

6.3.1 Interaction between Driver Age and Driver Performance

Driver Age was found to be a major contributor to accident involvement; Forbes (1972) mentioned that accidents and convictions for traffic offenses generally decrease with increasing age. The interaction between the driver performance and driver age was sought from 1101 respondents. Some of the teachers did not answer various questions , hence the cross tabulation of the factors resulted in 1045 respondents. Table 6.28 shows the observed frequency for the interaction

The interaction hypothesis was tested on a 5 % significance level and a Pearson X^2 test was performed for finding the independence or dependence of the survey data.. The over all X^2 value was found to be 31.2608 and p-value to be 2.27E-05.Since p-value is 2.27E-05 < 0.05, hence we can conclude that driver performance and driver age are related. Table 6.29 shows the X^2 contributions of each category. It was found that:

- Drivers under the age of 30 rated *excellent + good* injected a high inflation into the X^2 value. The expected values were lower than the observed.
- It was noted that drivers of age 30-40 having *bad + poor* performance rating had less accidents than expected. The expected values were more than they observed.

Table 6.28 : Observed frequency (f_{ij}) for interaction of driver performance and driver age

Driver performance	Driver Age				
	<30	30-40	40-50	> 50	Total
Excellent + good	154	264	237	201	856
Acceptable	9	45	30	44	128
Bad + poor	7	12	12	30	61
Total	170	321	279	275	1045

Table 6.29 : Contribution to X^2 values for interaction of driver performance and driver age

Driver performance	Driver Age				
	<30	30-40	40-50	> 50	Total
Excellent + good	1.56	0.00	0.31	2.61	4.49
Acceptable	6.71	0.82	0.51	3.16	11.20
Bad + poor	0.86	2.42	1.13	12.12	16.53
Total	9.14	3.25	1.95	17.89	32.23

- Similarly it was noted that drivers of age group 40-50 having *bad* + *poor* performance rating had lower observed values than expected.
- The drivers of age group > 50 having *excellent* + *good* rating also showed a decrease in expected values. However, the drivers of age group > 50 having rating *acceptable* and *poor* + *bad* showed an increase in expected values.

6.3.2 Interaction between Driver Performance and Vehicle Condition

A major factor contributing to the traffic death toll is the state of repair of vehicles in use on the highway. The interaction between driver performance and vehicle condition was sought from 1101 respondents. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1041 respondents. Table 6.30 shows the observed frequency for the interaction

A hypothesis was made about the interdependence of the driver performance and vehicle condition. The hypothesis was tested on a 5 % significance level and a Pearson X^2 test was performed for finding the independence or dependence of the survey data. The overall chi-squared value was found to be 308.687 and a p-value of 0.0000. Since p-value is $0.0000 < 0.05$, hence we can conclude that driver performance and vehicle condition are related. Table 6.31 shows the X^2 contributions of each category. It was found that:

- Drivers rated *bad* + *poor* having an *excellent* + *good* rated vehicle injected a high inflation into the chi-squared value. The expected values were 43.07 while they observed only 10.

- Drivers rated *bad + poor* having an *acceptable* rated vehicle observed 20 instead of the expected 11.11. Also, drivers rated *bad + poor* having *poor + bad* rated vehicle observed 29 instead of the 4.82 expected.

Table 6.30: Observed frequency (f_{ij}) for interaction of driver performance and vehicle condition

Driver performance	Vehicle Condition			
	Excellent + good	Acceptable	Bad + poor	Total
Excellent + good	709	109	38	856
Acceptable	41	67	18	126
Bad + poor	10	20	29	59
Total	760	196	85	1041

Table 6.31: Contribution to X^2 values for interaction of driver performance and vehicle condition

Driver performance	Vehicle Condition			
	Excellent + good	Acceptable	Bad + poor	Total
Excellent + good	11.31	16.89	14.55	42.75
Acceptable	28.26	78.95	5.78	112.99
Bad + poor	25.40	7.12	121.39	153.90
Total	64.97	102.95	141.72	309.64

- Drivers rated *excellent + good* with an *acceptable* rated vehicle experienced 109 instead of expected 161.17. Similarly, drivers rated *excellent + good* with *poor + bad* rated vehicle experienced 38 instead of 69.89 expected.

6.3.3 Interaction between Driver Performance and Driver Nationality

The interaction between driver performance and driver nationality was sought from 1101 respondents. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 731 respondents. Table 6.32 shows the observed frequency for the interaction.

The X^2 value was found to be 3.37 and a p-value of 0.18853. Since p-value is 0.18853 > 0.05, hence we can conclude that the driver performance and driver nationality are not related.

Table 6.32 : Observed Frequency (f_{ij}) for interaction of driver performance and driver nationality

Driver performance	Driver nationality		
	Saudi	Non Saudi	Total
Excellent + good	478	105	583
Acceptable	75	25	100
Bad + poor	41	7	48
Total	594	137	731

6.3.4 Interaction between Driver Performance and Vehicle Ownership

The interaction between driver performance and vehicle ownership was sought from 1101 respondents. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1029 respondents. Table 6.33 shows the observed frequency for the interaction

A hypothesis was made about the interdependence of the driver performance and driver vehicle ownership. This hypothesis was tested on a 5 % significance level and Pearson's X^2 test was performed for finding the independence or dependence of the survey data.. it was found that chi-value = 72.267 and a p-value 6.25E-15. Since p-value is 6.25E-15 < 0.05, hence the driver performance and driver vehicle ownership are related. Table 6.34 shows the contributing values for chi-squared (72.27). It was found that:

- Drivers who *do not own the vehicle* and having *poor p*erformance had 15 accidents instead of the four expected.
- Drivers who *own the vehicle* and having *poor* performance had 10 accidents instead of 21 accidents expected.

Table 6.33 : Observed frequency (f_{ij}) for interaction of driver performance and vehicle ownership

Driver performance	Vehicle ownership		
	No	Yes	Total
Excellent	30	389	419
Good	79	343	422
Acceptable	33	96	129
Bad	7	27	34
Poor	15	10	25
Total	164	865	1029

Table 6.34 : Contribution to chi-squared values for interaction of driver performance and vehicle ownership

Driver performance	Vehicle ownership		
	No	Yes	Total
Excellent	20.26	3.84	24.10
Good	2.05	0.39	2.44
Acceptable	7.53	1.43	8.95
Bad	0.46	0.09	0.55
Poor	30.45	5.77	36.23
Total	60.75	11.52	72.27

6.3.5 Interaction between Driver Performance and Teacher's Relationship to the driver

Table 6.35 shows the statistics obtained from revealed from the questionnaire survey done for a total of 1101 respondents. The interaction between driver performance and relationship to the teacher was sought. Some of the teachers did not answer various questions, hence the cross tabulation of the factors resulted in 1039 respondents.

A hypothesis was made about the independence of the driver's performance and teachers' relationship to the driver. It was found that chi-value = 61.08 and p-value = 2.77E-12. Since p-value is 2.77E-12< 0.05, hence we can conclude that driver performance and teachers' relationship to the driver are related. Table 6.34 shows the contributing values for chi-squared (61.08). It was found that:

- SPOUSES having *excellent* performance had 228 accidents while expected was 173. OTHERS having an *excellent* performance observed 193 instead of expected 248.
- SPOUSE having *poor* performance had seven accidents while expected was 11. OTHERS having a *poor* performance had 19 accidents instead of the 15 expected.

Table 6.35 : Observed frequency (f_{ij}) for interaction of driver performance and teacher's relationship to the driver.

Driver performance	Teacher's relationship to the driver		
	Spouse	Others	Total
Excellent	228	193	421
Good	158	273	431
Acceptable	30	97	127
Bad	5	29	34
Poor	7	19	26
Total	428	611	1039

Table 6.36 : Contribution to chi-squared values for interaction of driver performance and teacher's relationship to the driver.

Driver performance	Teacher's relationship to the driver		
	Spouse	Others	Total
Excellent	17.17	12.03	29.21
Good	2.15	1.51	3.66
Acceptable	9.52	6.67	16.19
Bad	5.79	4.06	9.85
Poor	1.29	0.90	2.19
Total	35.92	25.16	61.08

Chapter 7

ANALYSIS OF RELATIONSHIPS BETWEEN ACCIDENTS AND OTHER VARIABLES, USING A LOG-LINEAR MODEL

7.1. General purpose and description

One basic and straightforward way of analyzing data is via cross-tabulation. The log-linear analysis provides a more sophisticated way of looking at cross-tabulation tables. We used the STATISTICA software to analyze the data. Data was arranged and formatted to ease the process [see Tabachnick et al (2001).]

7.2 Model I: Relationship between driver performance and vehicle condition with respect to having accidents

This model studies the relationship between driver performance, vehicle condition, and its effect or relation with number of accidents. Driver performance has five categories: excellent, good, acceptable, poor, and bad. The categories are cross tabulated with vehicle condition and accident occurrence. Table 7.1 shows the frequency table.

A review of k-factor reveals the best model outcome. Table 7.2 shows the statistics for model I. Table 7.2 shows that there is improvement in fit when including all 2-way interactions (k-factor = 2). As the p-value for k=3 is more than 0.01 , therefore the improvement in fit when adding all 3-way interactions to the model (k-factor = 3) is not significant. The best model will contain some two-way interaction and probably some 3-way interaction having the driver performance (DRVPERF) , vehicle condition (VEHCOND) and number of accidents (ACC).

Table 7.3 shows the results of the marginal and partial association test , it was revealed that

- Interaction DRVPERF X VEHCOND is highly significant for both partial and marginal association.
- The interaction DRVPERF X ACC is also highly significant for both partial and marginal association.
- The interaction VEHCOND X ACC is only significant when the marginal association between the two factors is tested (p-value = 0.000) ; partial association is not significant (p-value = 0.322176).

From table 7.3 it can be concluded that the driver's performance and vehicle condition are highly correlated and driver performance and accident are also highly correlated. On the other hand, vehicle condition and accidents are only significant when taken alone. If considered with other factors they are not significant.

Table 7.1 Frequency table for model I

Survival data	Driver Performance	Vehicle Condition	Accident	Frequency
1	excellent	excellent	yes	30
2	good	excellent	yes	14
3	acceptable	excellent	yes	6
4	bad	excellent	yes	5
5	poor	excellent	yes	7
6	excellent	excellent	no	178
7	good	excellent	no	42
8	acceptable	excellent	no	5
.	.	.	.	.
.	.	.	.	.
49	bad	poor	no	7
50	poor	poor	no	5

Table 7.2 : Results of fitting all k-factor Interactions for model I

	degrees of	max. lik.	probab.	pearson	probab.
k-factor	freedom	chi-squ.	P	chi-squ	p
1	9	1635.188	0.000000	3009.069	0.000
2	24	491.8208	0.000000	733.6822	0.000
3	16	27.88109	0.032723	27.38606	0.037

Table 7.3 : Test of all marginal and partial associations for model I

	df	Partial assoc. X^2	Partial assoc. p	Marginal Assoc. X^2	Marginal assoc. p
DRVPERF X VEHCOND	**16**	**400.633**	**0.000000**	**429.239**	**0.000000**
DRVPERF X ACC	**4**	**29.29936**	**0.000007**	**57.90503**	**0.000000**
VEHCOND X ACC	4	4.676283	0.322176	33.28149	0.000001

Table 7.4 : Evaluation of goodness of fit for model I

Model I	Max. like. X^2	df	p-value	Pearson X^2	df	p-value
DRVPERF X VEHCOND + DRVPERF X ACC	**32.557**	**20**	**0.0377**	**32.41803**	**20**	**0.039114**
DRVPERF X VEHCOND	299.286	25	0.000000	277.8781	25	0.000000
DRVPERF X ACC	1097.03	40	0.000000	1074.865	40	0.000000
DRVPERF	1363.76	45	0.00000	1631.269	45	0.000000
VEHCOND	1519.655	45	0.00000	1957.168	45	0.00000
ACC	1946.065	48	0.00000	2799.907	48	0.00000

The best interactions based on out on k-factor and test of marginal and partial association is AB AC. The goodness of fit is evaluated as a final step.

It can be concluded the DRVPERF X VEHCOND + DRVPERF X ACC is best interaction.

7.3 Model II : Relationship between Driver Nationality and Driver Performance with Respect to Having Accidents

Model II attempts to study the relationship between the driver performance, driver nationality and its effect on or relation to the number of accidents. Driver performance has five categories (excellent, good, acceptable, poor, and bad). The categories are cross tabulated with driver nationality and accident occurrence. Table 7.5 shows the frequency table.

A review of k-factor reveals the best model outcome. Table 7.6 shows that there is improvement in fit when including all 2-way interactions (k-factor = 2). The improvement in fit when adding all 3-way interactions to the model (k-factor = 3) is not significant (p-value = 0.515). The best model will contain some two-way interaction and probably some 3- way interaction of driver nationality (DRVNAT), driver performance (DRVPERF) and number of accident (ACC).

Table 7.7 shows the results for the test of all marginal and partial associations for model II. The p-value from table 7.7 reveals that:

- Interaction DRVNAT X DRVPER is highly significant for both partial and marginal association.

Table 7.5 : Formatted data for model II

Survival data	Driver Nationality	Driver Performance	Accident	Frequency
1	saudi	excellent	yes	55
2	non-saudi	excellent	yes	13
3	saudi	excellent	No	235
4	non-saudi	excellent	No	47
5	saudi	Good	yes	93
6	non-saudi	Good	yes	32
7	saudi	Good	No	214
8	non-saudi	Good	No	79
.	.	.	.	.
.	.	.	.	.
19	saudi	Poor	No	9
20	non-saudi	Poor	No	5

Table 7.6 : Results of fitting all k-factor interactions for model II

	degrees of	max. lik.	probab.	pearson	probab.
k-factor	freedom	X^2	p	X^2	p
1	6	1368.175	0.000000	1798.162	0.000000
2	**9**	**30.06723**	**0.000429**	**28.81125**	**0.000700**
3	4	3.256061	0.515934	3.440097	0.487057

- The interaction DRVPERF X ACC is also highly significant for both partial and marginal association.
- The interaction DRVNAT X ACC is not significant for both marginal association and partial association between the two factors.

From table 7.7 it can be concluded that the drivers performance and driver nationality are correlated and driver performance and accident is also highly correlated. On the other hand driver nationality and accidents are not related.

The best interactions based on out on k-factor and test of marginal and partial association is DRVNAT X DRVPERF and DRVPERF X ACC. The good ness of fit is now evaluated as a final step.

It can be concluded the there exists a relation between (driver nationality X driver performance) and (driver performance X accident).

Table 7.7 : Test of all marginal and partial associations for model II

	df	Partial assoc. X^2	Partial assoc. p	Marginal assoc. X^2	Marginal assoc. p
DRVNAT X DRVPERF	4	9.942768	**0.041424**	**10.42673**	**0.033841**
DRVNAT X ACC	1	0.545083	0.460339	1.029358	0.310317
DRVPERF X ACC	4	**18.61088**	**0.000939**	**19.09521**	**0.000755**

Table 7.8 Evaluation of goodness of fit for model II

Model II	Max. lik X^2	df	p-value	Pearson X^2	df	p-value
DRVNAT X DRVPERF + DRVPERF X ACC	**3.801**	**5**	**0.578**	**4.142**	**5**	**0.529000**
DRVNAT X DRVPERF	287.6	10	0.000000	268.27	10	0.000000
DRVPERF X ACC	317.113	10	0.000000	296.341	10	0.000000
DRVNAT	1098.614	18	0.00000	1193.249	18	0.00000
DRVPERF	600.912	15	0.0000	663.799	15	0.00000
ACC	1136.794	18	0.00000	1284.664	18	0.00000

7.4 Model III : Relationship between Travel Distance and Travel Time with Respect to Having Accidents

This model attempts to study the relationship between travel distance, travel time, and its effect or relation to the number of accidents. Travel distance was categorized into < 30 , 30-80 and > 80 km. Table 7.9 shows the frequency table.

A review of k-factor reveals the best model outcome. The following statistics were obtained from model III. From the p-value in table 7.10 it can be observed that there is improvement in fit when including all 2-way interactions (k-factor = 2, p-value=0.0000). The improvement in fit when adding all 3-way interactions to the model (k-factor = 3, p-value = 0.24037) is not significant. The best model will contain two-way interaction.

The p-values in table 7.11 reveal that:

- Interaction TIME X DISTANCE is highly significant for both partial and marginal association.
- The interaction DISTANCE X ACC is also significant for both partial and marginal association.
- The interaction TIME X ACC is also significant for both marginal association and partial association between the two factors.

From table 7.10 and table 7.11 it can be concluded that the travel time and travel distance are correlated and travel distance and accident are also highly correlated. Travel time and accidents are also correlated.

Table 7.9 Formatted data for model III

Survival data	Travel Time	Travel distance	Accident	Frequency
1	<30	<30	yes	23
2	<30	<30	no	305
3	<30	30-80	yes	5
4	<30	30-80	no	21
5	<30	>80	yes	5
6	<30	>80	no	6
7	30-60	<30	yes	13
8	30-60	<30	no	80
.	.	.	.	.
.	.	.	.	.
23	>90	>80	yes	48
24	>90	>80	no	93

Table 7.10 : Results of fitting all k-factor Interactions for model III

	Degrees of	Max. Lik.	Probab.	Pearson	Probab.
K-factor	Freedom	X^2	p	X^2	p
1	6	635.94	0.00000	1529.06	0.00000
2	**11**	**1000.62**	**0.00000**	**1090.85**	**0.00000**
3	6	7.43	0.28270	7.97	0.24037

The best interactions based on out on k-factor and test of marginal and partial association are TIME X DISTANCE , TIME X ACC , DISTANCE X ACC . Good ness of fit is evaluated as a final step.

It can be concluded the there exists a relationship between travel time and travel distance; travel time and accident; and travel distance and accident. It should be noted that, there exist a number of possible explanation for this accident occurrence.

Table 7.11 : Test of all marginal and partial associations for model III

	df	Partial assoc. X^2	Partial ass. p	Marginal. assoc. X^2	Marginal. assoc. p
TIME X DISTANCE	6	838.4	0.00000	906.92041	0.00000
TIME X ACC	3	10.2	0.01734	78.67627	6.19E-17
DISTANCE X ACC	2	15.0	0.00055	83.549438	7.61E-19

Table 7.12 Evaluation of goodness of fit for model III

Model III	max. lik chi	df	p-value	pearson chi	df	p-value
TIME X DISTANCE + DISTANCE X ACC + TIME X ACC	**7.4296**	**6**	**0.2829**	**8.0066**	**6**	**0.23764**
TIME X DISTANCE + TIME X ACC	22.456	8	0.00414	22.553	8	0.003996
TIME X DISTANCE + DISTANCE X ACC	17.583	9	0.0403	20.437	9	0.01542
TIME X ACC + DISTANCE X ACC	845.827	12	0.0000	869.435	12	0.00000
TIME X DISTANCE	428.0179	12	0.0000	374.142	12	0.00000
TIME X ACC	997.1185	16	0.0000	963.549	16	0.00000
DISTANCE X ACC	1165.817	18	0.0000	1180.168	18	0.00000
TIME	1402.680	20	0.0000	1779.243	20	0.00000
DISTANCE	1576.251	21	0.0000	2112.013	21	0.00000
ACC	1317.108	22	0.0000	1631.346	22	0.00000

7.5 Model IV : Relationship between Driver Performance and Travel Distance with Respect to Having Accidents

In this model the relationship between driver performance, travel distance and its effect or relationship with number of accidents is sought. Travel distance was categorized into < 30 , 30-80 and > 80 km. Table 7.13 shows the frequency table.

Table 7.13 Formatted data for model IV

Survival data	Driver Performance	Travel distance	Accident	Frequency
1	ex+good	<30	yes	52
2	acceptable	<30	yes	9
3	bad+poor	<30	yes	5
4	ex+good	<30	no	336
5	acceptable	<30	no	16
6	bad+poor	<30	no	5
7	ex+good	30-80	yes	50
8	acceptable	30-80	yes	9
.	.	.	.	.
17	acceptable	> 80	no	32
18	bad+poor	> 80	no	5

A review of k-factor reveals the best model outcome. The following statistics were obtained from model IV. Table 7.14 shows that there is improvement in fit when including all 2-way interactions (k-factor = 2, p-value = 0.0000). The improvement in fit when adding all 3-way interactions to the model (k-factor = 3, p-value = 0.27564) is not

significant. The best model will contain some two-way interaction. The p-value in table 7.15 reveals that:

- Interaction DRVPERF X DISTANCE is highly significant for both partial and marginal association.
- The interaction DISTANCE X ACC is also significant for both partial and marginal association.
- The interaction DRVPERF X ACC is also significant for both marginal association and partial association between the two factors.

Table 7.14 Results of fitting all k-factor interactions for model IV

	degrees of	max. lik.	probab.	pearson	probab.
k-factor	freedom	X^2	p	X^2	p
1	5	1334.61	0.00000	2099.28	0.00000
2	**8**	**116.23**	**0.00000**	**139.89**	0.00000
3	4	5.12	0.27564	5.28	0.25955

From Table 7.15 it can be concluded that driver performance and travel distance are correlated, and travel distance and accident are also highly correlated. Driver performance and accidents are also correlated.

The best interactions based on out on k-factor and test of marginal and partial association are DRVPERF X DISTANCE , DRVPERF X ACC and DISTANCE X ACC. The goodness of fit is evaluated as a final step.

It can be concluded that there exists a relationship between driver performance and travel distance; driver performance and accident; and travel distance and accident. It should be noted that there exist a number of possible explanation for this accident occurrence.

Table 7.15 Test of all marginal and partial associations for model IV

	df	Partial assoc. X^2	Partial assoc. p	Marginal. assoc. X^2	Marginal assoc. p
DRVPERF X DISTANCE	4	51.12	0.000000	63.15	0.000000
DRVPERF X ACC	2	17.90	0.000130	29.93	0.000000
DISTANCE X ACC	2	23.16	0.000009	35.19	0.000000

7.6 Model V : Relationship between Driver Performance and Travel Cost with Respect to Having Accidents

This model attempts to find the relationship between driver performance, and travel cost, and its effect on or relationship with number of accidents. Table 7.17 shows the frequency table.

A review of k-factor reveals the best model outcome. The following statistics were obtained from Model V. Table 7.18 shows that there is improvement in fit when including all 2-way Interactions (k-factor = 2,p-value=0.0000). The improvement in fit when adding all 3-way Interactions to the model (k-factor = 3,p-value=0.597) is not significant. The best model will contain some two-way interaction.

The p-value of Table 7.19 reveals that:

Table 7.16 Evaluation of goodness of fit for model IV

Model IV	Max. lik X^2	df	p-value	Pearson X^2	df	p-value
DRVPERF X DISTANCE + DISTANCE X ACC + DRVPERF X ACC	**5.1159**	**4**	**0.27500**	**5.2828**	**4**	**0.2595**
DRVPERF X DISTANCE + DRVPERF X ACC	28.274	6	0.00008	28.1400	6	0.00008
DRVPERF X DISTANCE + DISTANCE X ACC	23.017	6	0.00022	26.00113	6	0.00022
DRVPERF X ACC + DISTANCE X ACC	56.238	8	0.00000	55.56300	8	0.00000
DRVPERF X DISTANCE	340.056	9	0.00000	311.4620	9	0.00000
DRVPERF X ACC	148.984	12	0.00000	153.5810	12	0.00000
DISTANCE X ACC	1081.364	12	0.00000	1081.542	12	0.00000
DRVPERF	460.766	15	0.00000	520.717	15	0.00000
DISTANCE	1398.403	15	0.00000	1848.63	15	0.00000
ACC	1174.11	16	0.00000	1387.906	16	0.00000

- Interaction DRVPERF X COST is highly significant for both partial and marginal association.

- The interaction COST X ACC is also significant for both partial and marginal association.

- The interaction DRVPERF X ACC is also significant for both marginal association and partial association between the two factors.

From Table 7.19 it can be concluded that driver performance and travel cost are correlated and travel cost and accident are also highly correlated. Driver performance and accidents are also correlated.

Table 7.17: Formatted data for model V

Survival data	Driver Performance	Travel cost	Accident	Frequency
1	excellent+good	< 500	yes	53
2	acceptable	< 500	yes	13
3	bad+poor	< 500	yes	5
4	excellent+good	< 500	no	336
5	acceptable	< 500	no	25
6	bad+poor	< 500	no	5
7	excellent+good	500-1000	yes	108
8	acceptable	500-1000	yes	27
.	.	.	.	.
.	.	.	.	.
17	acceptable	> 1000	no	18
18	bad+poor	> 1000	no	5

Table 7.18 : Results of fitting all k-factor Interactions for Model V

	degrees of	max. lik.	probab.	pearson	probab.
k-factor	freedom	chi-squ.	p	chi-squ	p
1	5	1686.02	0.00000	2565.79	0.00000
2	8	103.96	0.00000	119.87	0.00000
3	4	2.77	0.59735	2.83	0.58725

The best interactions based on out on k-factor and test of marginal and partial association are DRVPERF X COST , DRVPERF X ACC and COST X ACC . The goodness of fit is evaluated as a final step.

It can be concluded the there exists a relationship between driver performance and travel cost; driver performance and accident; and travel cost and accident. It should be noted that there exists a number of possible explanation for accident occurrence.

Table 7.19 Test of All Marginal and Partial Associations for Model V

	df	Partial assoc. X^2	Partial assoc. p	Marginal assoc. X^2	Marginal assoc. p
DRVPERF X COST	4	34.04	0.00000	43.85	0.00000
DRVPERF X ACC	2	32.95	0.00000	42.76	0.00000
COST X ACC	2	17.36	0.00017	27.16	0.00000

Table 7.20 Evaluation of Goodness of Fit for Model V

Model V	Max. lik X^2	df	p-value	Pearson X^2	df	p-value
DRVPERF X COST + COST X ACC + DRVPERF X ACC	**2.768**	**4**	**0.59700**	**2.8260**	**4**	**0.5872**
DRVPERF X COST + DRVPERF X ACC	20.123	6	0.00260	19.6035	6	0.00326
DRVPERF X COST + COST X ACC	35.718	6	0.00000	40.179	6	0.00000
DRVPERF X ACC + COST X ACC	36.810	8	0.00001	35.1201	8	0.00003
DRVPERF X COST	371.387	9	0.00000	341.982	9	0.00000
DRVPERF X ACC	328.621	12	0.00000	292.924	12	0.00000
COST X ACC	1192.44	12	0.00000	1207.827	12	0.00000
DRVPERF	679.884	15	0.00000	689.101	15	0.00000
COST	1528.108	15	0.00000	2023.752	15	0.00000
ACC	1484.250	16	0.00000	1776.747	16	0.00000

Chapter 8

CONCLUSIONS AND RECOMMENDATIONS

This research aims at obtaining causes of accidents occurring to female teachers during their journeys to and from work. This research relies on the questionnaire sent to female teachers all over the Kingdom. The questionnaire method was chosen because there were no police records mentioning whether the accident victim was a female teacher. Descriptive statistics, multi-way frequency tables and log-linear models were developed for the data set received. The following conclusions were found

8.1. Conclusions

- The majority of the teachers are married and teach in primary schools.
- Most of the teachers rely on their spouse to reach their work place, use the passenger car as their mode of travel, and spend 681 riyal monthly on an average.
- The majority of the drivers are Saudi and in the age group of 30-40.
- The majority of females are "captive" to their mode of travel, i.e. most of them choose their mode because they have no other option.
- It was found that tire failure, speeding, other vehicle problems and bad weather remain the major causes of road traffic accident.
- It was found that about 25% of the respondents had experienced an accident in the last 3 years.

8.2 Accident Analysis Conclusions

- Most of the accidents were caused by Asian drivers who constituted 7% of the total.
- The teachers traveling with their spouse (42% of the total) experienced less accidents.
- Drivers who did not own the vehicle (20%) were more involved in accidents.
- Teachers traveling in buses and passenger cars experienced fewer accidents.
- Drivers of company vehicles (9% of total) were more involved in accidents.
- Most of the teachers who were involved in accidents traveled more than 80 km i.e. distance is a significant factor.
- Driver aged less than 30, or over 50, showed poor compliance with traffic safety laws.
- Driver performance and driver nationality are not related.

8.3 Log-Linear Modeling Conclusions

The interaction of a number of variable combinations (more than two variables) was modeled and the following conclusions were found from the models.

1. The major factors associated with female teachers' accidents in last 3 years are driver performance and the condition of the vehicle in which the teacher is traveling.

2. The driver's nationality did not relate to the accidents experienced by the female teachers in the last 3 years.

3. There is an association between driver performance and the amount spent on travel by female teachers, with the accidents experienced by female teachers in the last 3 years.

4. The time spent in traveling by female teachers and the distance traveled during their work trip is associated with the accidents in the last 3 year.

5. There is an association between the driver's performance and the distance traveled by the teacher with the accidents experienced by the teachers in the last 3 years.

8.4 Recommendations

- Vehicle occupancy should be increased so that sharing can reduce travel costs.
- Residences near schools should be provided for the female teachers in order to minimize the travel exposure.
- Special bus services should be organized in order to facilitate the captive riders.
- Traffic laws should be strictly enforced and implemented on the drivers of female teachers to reduce the speeding.
- It is recommended to hire drivers having their own vehicles for work, or provide the driver some liability on the vehicle (e.g. maintenance).

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APPENDICES

APPENDIX A : CODING MANUAL (ENGLISH)

Column	Question No.	Variables and Codes
1	-	Questionnaire ID.
2	1	School Type 1 = Elementary 2 = Intermediate 3 = Secondary 4 = Elementary + Intermediate 5 = Intermediate + Secondary 6 = Elementary + Intermediate + Secondary
3	1	Branch Code
4	1	Province Code
5	2	Marital Status(Give the following codes) 1 = Married 2 = Non-Married
6	3	No of years in this school. (put in numbers)
7	4	Total no of years in service (put in numbers)
8	5	You use Inter city Transport to reach your work place 1 = Yes 2 = No
9	6	Is the City you live in same as the city where school is located 1 = Yes 2 = No
10	7	Mode of Transportation 1 = Passenger Car 2 = Taxi/Limousine 3 = Van 4 = Suburban 5 = Bus
11	8	Who Own the transportation mode 1 = Your Relative or your friend relative 2 = Transportation establishment 3 = Self Employee 4 = Others

12	8	Name of transportation establishment 1 = written 2 = missing
13	9	How much do you spend monthly for transportation (In Saudi Riyals)
14	10	Is the driver 1 = Your relative or your friends relative 2 = Other Driver
15	10	Nationality 1 = Saudi 2 = Arab 3 = South Eastern 4 = Far Eastern
16	11	How old is the driver 1 = Less than 30 years 2 = between 30-40 years 3 = between 40-50 years 4 = between 50-60 years 5 = more than 60 years
17	12	How do you evaluate the driver with respect to traffic safety 1 = Excellent 2 = Good 3 = Acceptable 4 = Poor 5 = Bad
18	13	Vehicle Manufacturer 1 = Japanese 2 = American 3 = Korean 4 = Europe 5 = Other
19	14	Model Year Put in - - - - Format
20	15	General condition of vehicle 1 = Excellent 2 = Good 3 = Acceptable 4 = Bad 5 = poor

21	16	Do you have other mode choice 1 = Yes 2 = No
22	17	How many teachers are joining you in this vehicle(put the number)
23	18	What is the travel time between home and school (Oneway) (write in minutes)
24	19	What is the trip distance from home to school (Oneway) (Put the numbers in KM)
25	20	What is the reason behind your mode choice 1 = Best in respect of security 2 = Best in respect of traffic safety 3 = Best in respect of Cost 4 = No other chioce 5 = Personal comfort 6 = other
26	21	Does the driver of the vehicle owns it. 1 = Yes 2 = No
27	22	You have any traffic accident during last 3 years while going to or coming from school 1 = Yes 2 = No
IF ANSWER IS "NO" GO TO QUESTION 26		
		Accidents that happened while going to school
28	23	Number of Severe Accidents
29	23	Number of Minor Injury accidents
30	23	Number of No Injury accidents
		Accidents that happened while coming to school
31	24	Number of Severe Accidents
32	24	Number of Minor Injury accidents

33	24	No of No Injury accidents
34	25	What do you think is the cause of these accidents (Check all that apply) Causes related to Vehicle Flat Tire 1 = Yes 0 = No
35	25	Vehicle steering arms 1 = Yes 0 = No
36	25	Vehicle lighting 1 = Yes 0 = No
37	25	Vehicle brakes 1 = Yes 0 = No
38	25	Fire in vehicle 1 = Yes 0 = No
39	25	Vehicle age 1 = Yes 0 = No
40	25	Others 1 = Yes 0 = No
41	25	Driver mistakes Over speed 1 = Yes 0 = No
42	25	Not obeying the traffic rules 1 = Yes 0 = No
43	25	Reckless driving 1 = Yes 0 = No
44	25	Crossing on red 1 = Yes 0 = No
45	25	Driver fell asleep 1 = Yes 0 = No

Expected Frequencies (province.sta)
Row variables : PROVINCE(9)
Column variables: ACCIDENT(2)

	NO	YES	Total
PROV1	234.8653576	67.13464236	302
PROV2	36.55189341	10.44810659	47
PROV3	136.0974755	38.90252454	175
PROV4	142.3190743	40.68092567	183
PROV5	235.6430575	67.3569425	303
PROV6	66.10448808	18.89551192	85
PROV7	78.54768583	22.45231417	101
PROV8	41.21809257	11.78190743	53
PROV9	137.6528752	39.34712482	177
Total	1109	317	1426

Observed minus Expected Frequencies (province.sta)
Row variables: PROVINCE(9)
Column variables: ACCIDENT(2)

	NO	YES
PROV1	-1.865357644	1.865357644
PROV2	2.448106592	-2.448106592
PROV3	-15.09747546	15.09747546
PROV4	17.68092567	-17.68092567
PROV5	-5.643057504	5.643057504
PROV6	-6.104488079	6.104488079
PROV7	5.452314165	-5.452314165
PROV8	-8.218092567	8.218092567
PROV9	11.34712482	-11.34712482

Standardized Deviates (province.sta)
Row variables: PROVINCE(9)
Column variables: ACCIDENT(2)

	NO	YES	Total
PROV1	-0.121717389	0.227661069	0.105944
PROV2	0.40492574	-0.757375977	-0.35245
PROV3	-1.29413415	2.4205577	1.126424
PROV4	1.48208613	-2.772104419	-1.290018
PROV5	-0.36760986	0.687580091	0.31997
PROV6	-0.750816446	1.40433241	0.653516
PROV7	0.615196952	-1.150668746	-0.535472
PROV8	-1.280050441	2.394215431	1.114165
PROV9	0.967148559	-1.808961529	-0.841813
Total	-0.344970906	0.645236031	0.300265

Percentages of Total (province.sta)
Row variables: PROVINCE(9)
Column variables: ACCIDENT(2)

	NO	YES	Total
PROV1	16.33941094	4.838709677	21.17812
PROV2	2.734922861	0.561009818	3.295933
PROV3	8.485273492	3.786816269	12.27209
PROV4	11.22019635	1.612903226	12.8331
PROV5	16.12903226	5.119214586	21.24825
PROV6	4.207573633	1.75315568	5.960729
PROV7	5.890603086	1.192145863	7.082749
PROV8	2.314165498	1.402524544	3.71669
PROV9	10.44880785	1.963534362	12.41234
Total	77.76998597	22.23001403	100

Percentages of Row Totals (province.sta)
Row variables: PROVINCE(9)
Column variables: ACCIDENT(2)

	NO	YES	Total
PROV1	77.15231788	22.84768212	100
PROV2	82.9787234	17.0212766	100
PROV3	69.14285714	30.85714286	100
PROV4	87.43169399	12.56830601	100
PROV5	75.90759076	24.09240924	100
PROV6	70.58823529	29.41176471	100
PROV7	83.16831683	16.83168317	100
PROV8	62.26415094	37.73584906	100
PROV9	84.18079096	15.81920904	100

Percentages of Column Totals (province.sta)
Row variables: PROVINCE(9)
Column variables: ACCIDENT(2)

	NO	YES
PROV1	21.00991885	21.76656151
PROV2	3.516681695	2.523659306
PROV3	10.91073039	17.03470032
PROV4	14.42741208	7.255520505
PROV5	20.73940487	23.02839117
PROV6	5.410279531	7.886435331
PROV7	7.574391344	5.362776025
PROV8	2.975653742	6.309148265
PROV9	13.4355275	8.832807571
Total	100	100

Expected Frequencies (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
SAUDI	601.0529	156.9471	758
ARAB	49.95558	13.04442	63
WESTASI	88.80993	23.19007	112
EASTASI	27.7531	7.246897	35
OTHERS	446.4285	116.5715	563
Total	1214	317	1531

Observed minus Expected Frequencies (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES
SAUDI	-11.05291	11.05291
ARAB	3.044415	-3.044415
WESTASI	-7.809928	7.809928
EASTASI	-3.753103	3.753103
OTHERS	19.57152	-19.57152

Contributions to Chi-Square (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
SAUDI	0.203255	0.778394	0.981649
ARAB	0.185534	0.710531	0.896065
WESTASI	0.686804	2.630219	3.317023
EASTASI	0.507539	1.943698	2.451237
OTHERS	0.85802	3.285918	4.143938
Total	2.441151	9.348761	11.78991

Standardized Deviates (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
SAUDI	-0.450838	0.882267	0.431429
ARAB	0.430737	-0.84293	-0.412193
WESTASI	-0.828736	1.621795	0.793059
EASTASI	-0.712418	1.394166	0.681748
OTHERS	0.926294	-1.81271	-0.886417
Total	-0.634961	1.242587	0.607626

Percentages of Row Totals (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
SAUDI	77.83641	22.16359	100
ARAB	84.12698	15.87302	100
WESTASI	72.32143	27.67857	100
EASTASI	68.57143	31.42857	100
OTHERS	82.77087	17.22913	100

Percentages of Column Totals (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES
SAUDI	48.59967	52.99685
ARAB	4.365733	3.154574
WESTASI	6.672158	9.77918
EASTASI	1.976936	3.470032
OTHERS	38.3855	30.59937
Total	100	100

Percentages of Total (nationality.sta)
Row variables: NATIONTY(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
SAUDI	38.5369	10.97322	49.51012
ARAB	3.46179	0.653168	4.114958
WESTASI	5.29066	2.02482	7.31548
EASTASI	1.567603	0.718485	2.286088
OTHERS	30.43762	6.335728	36.77335
Total	79.29458	20.70542	100

Expected Frequencies (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	502.4464	135.5536	638
GOOD	480.3954	129.6046	610
ACCEPTAB	120.4926	32.50737	153
BAD	28.35121	7.648794	36
POOR	43.31434	11.68566	55
Total	1175	317	1492

Observed minus Expected Frequencies (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES
EXCELLEN	44.55362	-44.55362
GOOD	-7.395442	7.395442
ACCEPTAB	-21.49263	21.49263
BAD	-13.35121	13.35121
POOR	-2.314343	2.314343

Contributions to Chi-Square (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	3.95072	14.64384	18.59456
GOOD	0.113849	0.421996	0.535845
ACCEPTAB	3.833704	14.2101	18.0438
BAD	6.287377	23.30494	29.59232
POOR	0.123658	0.458355	0.582014
Total	14.30931	53.03923	67.34854

Standardized Deviates (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	1.987642	-3.826727	-1.839085
GOOD	-0.337415	0.649612	0.312197
ACCEPTAB	-1.957985	3.769629	1.811644
BAD	-2.507464	4.82752	2.320055
POOR	-0.351651	0.67702	0.325368
Total	-3.166873	6.097053	2.93018

Percentages of Row Totals (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	85.73668	14.26332	100
GOOD	77.54098	22.45902	100
ACCEPTAB	64.70588	35.29412	100
BAD	41.66667	58.33333	100
POOR	74.54545	25.45455	100

Percentages of Column Totals (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES
EXCELLEN	46.55319	28.70662
GOOD	40.25532	43.21767
ACCEPTAB	8.425532	17.0347
BAD	1.276596	6.624606
POOR	3.489362	4.416404
Total	100	100

Percentages of Total (driver perf.sta)
Row variables: VEH_CON(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	36.6622	6.099196	42.76139
GOOD	31.70241	9.182306	40.88472
ACCEPTAB	6.635389	3.619303	10.25469
BAD	1.005362	1.407507	2.412869
POOR	2.747989	0.938338	3.686327
Total	78.75335	21.24665	100

Expected Frequencies (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	33.11792	8.882075	42
JAPANESE	561.4277	150.5723	712
AMERICAN	365.8742	98.12579	464
KOREAN	17.34748	4.652516	22
EUROPEAN	25.2327	6.767296	32
Total	1003	269	1272

Observed minus Expected Frequencies (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES
OTHERS	3.882075	-3.882075
JAPANESE	11.57233	-11.57233
AMERICAN	-18.87421	18.87421
KOREAN	-0.347484	0.347484
EUROPEAN	3.767296	-3.767296

Contributions to Chi-Square (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	0.455056	1.696733	2.151789
JAPANESE	0.238533	0.889398	1.127931
AMERICAN	0.973657	3.630401	4.604058
KOREAN	0.00696	0.025953	0.032913
EUROPEAN	0.562465	2.097221	2.659686
Total	2.236671	8.339706	10.57638

Standardized Deviates (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	0.674578	-1.302587	-0.628009
JAPANESE	0.488398	-0.943079	-0.454681
AMERICAN	-0.986741	1.905361	0.918621
KOREAN	-0.083429	0.161098	0.077669
EUROPEAN	0.749977	-1.448179	-0.698202
Total	0.842784	-1.627385	-0.784602

Percentages of Row Totals (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	88.09524	11.90476	100
JAPANESE	80.47753	19.52247	100
AMERICAN	74.78448	25.21552	100
KOREAN	77.27273	22.72727	100
EUROPEAN	90.625	9.375	100

Percentages of Column Totals (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES
OTHERS	3.688933	1.858736
JAPANESE	57.12861	51.67286
AMERICAN	34.59621	43.49442
KOREAN	1.694915	1.858736
EUROPEAN	2.891326	1.115242
Total	100	100

Percentages of Total (manufacturer.sta)
Row variables: MANUFACT(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	2.908805	0.393082	3.301887
JAPANESE	45.04717	10.92767	55.97484
AMERICAN	27.27987	9.198113	36.47799
KOREAN	1.336478	0.393082	1.72956
EUROPEAN	2.279874	0.235849	2.515723
Total	78.8522	21.1478	100

Expected Frequencies (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	325.7864	89.2136	415
GOOD	548.7342	150.2658	699
ACCEPTAB	193.9018	53.09821	247
BAD	60.44712	16.55288	77
POOR	14.13049	3.869505	18
Total	1143	313	1456

Observed minus Expected Frequencies (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES
EXCELLEN	34.2136	-34.2136
GOOD	6.265797	-6.265797
ACCEPTAB	-25.90179	25.90179
BAD	-11.44712	11.44712
POOR	-3.130495	3.130495

Contributions to Chi-Square (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	3.593061	13.12099	16.71405
GOOD	0.071547	0.261272	0.332819
ACCEPTAB	3.460012	12.63512	16.09514
BAD	2.167787	7.916231	10.08402
POOR	0.693535	2.532622	3.226158
Total	9.985942	36.46623	46.45218

Standardized Deviates (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	1.895537	-3.62229	-1.726753
GOOD	0.267482	-0.511147	-0.243665
ACCEPTAB	-1.860111	3.554592	1.694481
BAD	-1.472341	2.81358	1.341239
POOR	-0.832788	1.591421	0.758634
Total	-2.002219	3.826155	1.823936

Percentages of Row Totals (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	86.74699	13.25301	100
GOOD	79.39914	20.60086	100
ACCEPTAB	68.01619	31.98381	100
BAD	63.63636	36.36364	100
POOR	61.11111	38.88889	100

Percentages of Column Totals (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES
EXCELLEN	31.49606	17.57188
GOOD	48.55643	46.00639
ACCEPTAB	14.69816	25.23962
BAD	4.286964	8.945687
POOR	0.96238	2.236422
Total	100	100

Percentages of Total (veh cond.sta)
Row variables: VEH_COND(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
EXCELLEN	24.72527	3.777473	28.50275
GOOD	38.11813	9.89011	48.00824
ACCEPTAB	11.53846	5.425824	16.96429
BAD	3.365385	1.923077	5.288462
POOR	0.755495	0.480769	1.236264
Total	78.50275	21.49725	100

Expected Frequencies (driver relation.sta)
Row variables: DR_REL(2)
Column variables: ACCIDENT(2)

	NO	YES	Total
SPOUSE	501.5158	143.4842	645
OTHER	606.4842	173.5158	780
Total	1108	317	1425

Observed minus Expected Frequencies (driver relation.sta)
Row variables: DR_REL(2)
Column variables: ACCIDENT(2)

	NO	YES
SPOUSE	42.48421	-42.48421
OTHER	-42.48421	42.48421

Contributions to Chi-Square (driver relation.sta)
Row variables: DR_REL(2)
Column variables: ACCIDENT(2)

	NO	YES	Total
SPOUSE	3.598906	12.57914	16.17805
OTHER	2.976018	10.40198	13.378
Total	6.574924	22.98112	29.55605

Standardized Deviates (driver relation.sta)
Row variables: DR_REL(2)
Column variables: ACCIDENT(2)

	NO	YES	Total
SPOUSE	1.897078	-3.546709	-1.64963
OTHER	-1.725114	3.22521	1.500096
Total	0.171964	-0.321498	-0.149534

Percentages of Total (driver relation.sta)
Row variables: DR_REL(2)
Column variables: ACCIDENT(2)

	NO	YES	Total
SPOUSE	38.17544	7.087719	45.26316
OTHER	39.57895	15.15789	54.73684
Total	77.75439	22.24561	100

Expected Frequencies (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES	Total
SECURITY	101.5437	29.45626	131
TRAFFSA	33.33115	9.668847	43
COST	11.62715	3.372854	15
NOOTHER	577.4816	167.5184	745
CONVEVNI	219.3655	63.63451	283
OTHER	4.650859	1.349141	6
Total	948	275	1223

Observed minus Expected Frequencies (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES
SECURITY	9.456255	-9.456255
TRAFFSA	5.668847	-5.668847
COST	0.372854	-0.372854
NOOTHER	-46.4816	46.4816
CONVEVNI	30.63451	-30.63451
OTHER	0.349141	-0.349141

Contributions to Chi-Square (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES	Total
SECURITY	0.880613	3.035714	3.916327
TRAFFSA	0.964138	3.323646	4.287784
COST	0.011956	0.041217	0.053174
NOOTHER	3.741313	12.89733	16.63864
CONVEVNI	4.278125	14.74786	19.02599
OTHER	0.02621	0.090354	0.116564
Total	9.902355	34.13612	44.03847

Standardized Deviates (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES	Total
SECURITY	0.93841	-1.74233	-0.80392
TRAFFSA	0.981905	-1.823087	-0.841182
COST	0.109346	-0.20302	-0.093675
NOOTHER	-1.934247	3.591285	1.657037
CONVEVNI	2.068363	-3.840295	-1.771932
OTHER	0.161896	-0.300589	-0.138693
Total	2.325672	-4.318036	-1.992364

Percentages of Row Totals (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES	Total
SECURITY	84.73282	15.26718	100
TRAFFSA	90.69767	9.302326	100
COST	80	20	100
NOOTHER	71.27517	28.72483	100
CONVEVNI	88.33922	11.66078	100
OTHER	83.33333	16.66667	100

Percentages of Column Totals (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES
SECURITY	11.70886	7.272727
TRAFFSA	4.113924	1.454545
COST	1.265823	1.090909
NOOTHER	56.01266	77.81818
CONVEVNI	26.37131	12
OTHER	0.527426	0.363636
Total	100	100

Percentages of Total (reason for current.sta)
Row variables: REAS_MOD(6)
Column variables: ACCIDENT(2)

	NO	YES	Total
SECURITY	9.076043	1.635323	10.71137
TRAFFSA	3.18888	0.327065	3.515944
COST	0.981194	0.245298	1.226492
NOOTHER	43.41783	17.49796	60.91578
CONVEVNI	20.44154	2.698283	23.13982
OTHER	0.408831	0.081766	0.490597
Total	77.51431	22.48569	100

Expected Frequencies (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	76.36645	21.63355	98
SPOUSE	513.5254	145.4746	659
COMPANY	77.92494	22.07506	100
SELFEMP	391.1832	110.8168	502
Total	1059	300	1359

Observed minus Expected Frequencies (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES
OTHERS	1.633554	-1.633554
SPOUSE	38.47461	-38.47461
COMPANY	-16.92494	16.92494
SELFEMP	-23.18322	23.18322

Contributions to Chi-Square (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	0.034943	0.12335	0.158293
SPOUSE	2.882615	10.17563	13.05825
COMPANY	3.676021	12.97636	16.65238
SELFEMP	1.373939	4.850004	6.223943
Total	7.967518	28.12534	36.09286

Standardized Deviates (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	0.186931	-0.351212	-0.164281
SPOUSE	1.697827	-3.189926	-1.4921
COMPANY	-1.917295	3.602271	1.684976
SELFEMP	-1.172151	2.202272	1.030121
Total	-1.204689	2.263405	1.058716

Percentages of Row Totals (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	79.59184	20.40816	100
SPOUSE	83.76328	16.23672	100
COMPANY	61	39	100
SELFEMP	73.30677	26.69323	100

Percentages of Column Totals (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES
OTHERS	7.365439	6.666667
SPOUSE	52.12465	35.66667
COMPANY	5.760151	13
SELFEMP	34.74976	44.66667
Total	100	100

Percentages of Total (owner of veh..sta)
Row variables: VEH_OWN(4)
Column variables: ACCIDENT(2)

	NO	YES	Total
OTHERS	5.739514	1.47167	7.211185
SPOUSE	40.6181	7.873436	48.49154
COMPANY	4.488595	2.869757	7.358352
SELFEMP	27.07873	9.860191	36.93893
Total	77.92494	22.07506	100

Expected Frequencies (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
PAX	626.5097	180.4903	807
TAXI	58.22581	16.77419	75
VAN	178.5591	51.44086	230
SUBURBA	197.9677	57.03226	255
BIGBUS	21.73763	6.262366	28
Total	1083	312	1395

Observed minus Expected Frequencies (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES
PAX	29.49032	-29.49032
TAXI	-2.225806	2.225806
VAN	-15.55914	15.55914
SUBURBA	-13.96774	13.96774
BIGBUS	2.262366	-2.262366

Contributions to Chi-Square (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
PAX	1.388134	4.818425	6.206559
TAXI	0.085086	0.295347	0.380434
VAN	1.35578	4.706119	6.061899
SUBURBA	0.985503	3.420833	4.406336
BIGBUS	0.235458	0.817311	1.052769
Total	4.04996	14.05804	18.108

Standardized Deviates (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
PAX	1.178191	-2.195091	-1.0169
TAXI	-0.291695	0.543459	0.251763
VAN	-1.164379	2.169359	1.00498
SUBURBA	-0.992725	1.849549	0.856824
BIGBUS	0.48524	-0.904052	-0.418812
Total	-0.785369	1.463224	0.677855

Percentages of Row Totals (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
PAX	81.28872	18.71128	100
TAXI	74.66667	25.33333	100
VAN	70.86957	29.13043	100
SUBURBA	72.15686	27.84314	100
BIGBUS	85.71429	14.28571	100

Percentages of Column Totals (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES
PAX	60.57248	48.39744
TAXI	5.170822	6.089744
VAN	15.05078	21.47436
SUBURBA	16.98984	22.75641
BIGBUS	2.216066	1.282051
Total	100	100

Percentages of Total (mode of trans.sta)
Row variables: TRA_MODE(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
PAX	47.02509	10.82437	57.84946
TAXI	4.014337	1.362007	5.376344
VAN	11.68459	4.802867	16.48746
SUBURBA	13.18996	5.089606	18.27957
BIGBUS	1.72043	0.286738	2.007168
Total	77.63441	22.36559	100

Expected Frequencies (distance acident.sta)
Row variables: DISTANCE(7)
Column variables: ACCIDENT(2)

	NO	YES	Total
30-40	58.02075	20.97925	79
40-50	35.25311	12.74689	48
50-60	21.29876	7.701245	29
<30	170.39	61.60996	232
60-70	15.42324	5.576763	21
70-80	41.12863	14.87137	56
>80	189.4855	68.51452	258
Total	531	192	723

Observed minus Expected Frequencies (distance acident.sta)
Row variables: DISTANCE(7)
Column variables: ACCIDENT(2)

	NO	YES
30-40	-1.020747	1.020747
40-50	-4.253112	4.253112
50-60	0.701245	-0.701245
<30	24.60996	-24.60996
60-70	-0.423237	0.423237
70-80	-0.128631	0.128631
>80	-19.48548	19.48548

Contributions to Chi-Square (distance acident.sta)
Row variables: DISTANCE(7)
Column variables: ACCIDENT(2)

	NO	YES	Total
30-40	0.017958	0.049665	0.067622
40-50	0.513117	1.419088	1.932205
50-60	0.023088	0.063853	0.086941
<30	3.554492	9.830392	13.38488
60-70	0.011614	0.032121	0.043735
70-80	0.000402	0.001113	0.001515
>80	2.003762	5.541655	7.545417
Total	6.124433	16.93789	23.06232

Standardized Deviates (distance acident.sta)
Row variables: DISTANCE(7)
Column variables: ACCIDENT(2)

	NO	YES	Total
30-40	-0.134007	0.222855	0.088849
40-50	-0.716322	1.191255	0.474933
50-60	0.151947	-0.252691	-0.100744
<30	1.885336	-3.135346	-1.25001
60-70	-0.107769	0.179222	0.071453
70-80	-0.020057	0.033356	0.013298
>80	-1.415543	2.354072	0.938529
Total	-0.356415	0.592724	0.236309

Percentages of Row Totals (distance acident.sta)

	NO	YES	Total
30-40	72.1519	27.8481	100
40-50	64.58333	35.41667	100
50-60	75.86207	24.13793	100
<30	84.05172	15.94828	100
60-70	71.42857	28.57143	100
70-80	73.21429	26.78571	100
>80	65.89147	34.10853	100

Percentages of Column Totals (distance acident.sta)
Row variables: DISTANCE(7)
Column variables: ACCIDENT(2)

	NO	YES
30-40	10.73446	11.45833
40-50	5.838041	8.854167
50-60	4.143126	3.645833
<30	36.72316	19.27083
60-70	2.824859	3.125
70-80	7.721281	7.8125
>80	32.01507	45.83333
Total	100	100

Percentages of Total (distance acident.sta)
Row variables: DISTANCE(7)
Column variables: ACCIDENT(2)

	NO	YES	Total
30-40	7.883817	3.042877	10.92669
40-50	4.28769	2.351314	6.639004
50-60	3.042877	0.968188	4.011065
<30	26.97095	5.117566	32.08852
60-70	2.074689	0.829876	2.904564
70-80	5.670816	2.074689	7.745505
>80	23.51314	12.17151	35.68465
Total	73.44398	26.55602	100

Expected Frequencies (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
<30	194.4379	68.56212	263
30-45	164.8656	58.13442	223
45-60	113.8534	40.14664	154
60-75	27.35438	9.645621	37
75	225.4888	79.5112	305
Total	726	256	982

Observed minus Expected Frequencies (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES
<30	37.56212	-37.56212
30-45	5.13442	-5.13442
45-60	0.14664	-0.14664
60-75	-7.354379	7.354379
75	-35.4888	35.4888

Contributions to Chi-Square (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
<30	7.256367	20.5786	27.83497
30-45	0.159902	0.453471	0.613372
45-60	0.000189	0.000536	0.000724
60-75	1.977266	5.607403	7.584669
75	5.585443	15.83997	21.42541
Total	14.97917	42.47998	57.45915

Standardized Deviates (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
<30	2.693765	-4.536365	-1.8426
30-45	0.399877	-0.673402	-0.273526
45-60	0.013743	-0.023143	-0.0094
60-75	-1.406153	2.367996	0.961843
75	-2.363354	3.979946	1.616591
Total	-0.662123	1.115031	0.452908

Percentages of Row Totals (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
<30	88.21293	11.78707	100
30-45	76.23318	23.76682	100
45-60	74.02597	25.97403	100
60-75	54.05405	45.94595	100
75	62.29508	37.70492	100

Percentages of Column Totals (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES
<30	31.95592	12.10938
30-45	23.41598	20.70313
45-60	15.70248	15.625
60-75	2.754821	6.640625
75	26.1708	44.92188
Total	100	100

Percentages of Total (time acident.sta)
Row variables: TIME(5)
Column variables: ACCIDENT(2)

	NO	YES	Total
<30	23.62525	3.156823	26.78208
30-45	17.31161	5.397149	22.70876
45-60	11.60896	4.07332	15.68228
60-75	2.03666	1.731161	3.767821
75	19.34827	11.71079	31.05906
Total	73.93075	26.06925	100

Expected Frequencies (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60	Total
EXCELLEN	108.9777	201.5223	156.5474	118.4916	35.461	621
GOOD	105.2925	194.7075	151.2535	114.4847	34.26184	600
ACCEPTAB	26.49861	49.00139	38.06546	28.81198	8.622563	151
BAD	6.317549	11.68245	9.075209	6.869081	2.05571	36
POOR	4.913649	9.086351	7.058496	5.342618	1.598886	28
Total	252	466	362	274	82	1436

Observed minus Expected Frequencies (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60
EXCELLEN	33.02228	32.47772	-29.54735	-29.49164	-6.461003
GOOD	-12.29248	-27.70752	36.74652	-2.48468	5.738162
ACCEPTAB	-16.49861	2.998607	-3.06546	15.18802	1.377437
BAD	-3.317549	-6.682451	-3.075209	14.13092	-1.05571
POOR	-0.913649	-1.086351	-1.058496	2.657382	0.401114

Contributions to Chi-Square (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60	Total
EXCELLEN	10.00637	5.234171	5.576882	7.340239	1.177196	29.33486
GOOD	1.435098	3.942871	8.927441	0.053925	0.961025	15.32036
ACCEPTAB	10.27239	0.183498	0.246865	8.006254	0.220043	18.92905
BAD	1.742152	3.822413	1.04206	29.06981	0.54216	36.2186
POOR	0.169885	0.129883	0.158733	1.321763	0.100628	1.880891
Total	23.62589	13.31284	15.95198	45.79199	3.001053	101.6838

Standardized Deviates (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60	Total
EXCELLEN	3.163285	2.287831	-2.361542	-2.709288	-1.084987	-0.704701
GOOD	-1.197956	-1.985666	2.987882	-0.232218	0.980319	0.552361
ACCEPTAB	-3.205057	0.428366	-0.496855	2.829533	0.469087	0.025074
BAD	-1.319906	-1.955099	-1.020813	5.391643	-0.736315	0.359509
POOR	-0.412171	-0.360392	-0.398413	1.14968	0.317219	0.295923
Total	-2.971805	-1.584961	-1.289741	6.429349	-0.054677	0.528165

Percentages of Row Totals (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60	Total
EXCELLEN	22.86634	37.68116	20.45089	14.33172	4.669887	100
GOOD	15.5	27.83333	31.33333	18.66667	6.666667	100
ACCEPTAB	6.622517	34.43709	23.17881	29.13907	6.622517	100
BAD	8.333333	13.88889	16.66667	58.33333	2.777778	100
POOR	14.28571	28.57143	21.42857	28.57143	7.142857	100

Percentages of Column Totals (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60
EXCELLEN	56.34921	50.21459	35.08287	32.48175	35.36585
GOOD	36.90476	35.83691	51.9337	40.87591	48.78049
ACCEPTAB	3.968254	11.1588	9.668508	16.05839	12.19512
BAD	1.190476	1.072961	1.657459	7.664234	1.219512
POOR	1.587302	1.716738	1.657459	2.919708	2.439024
Total	100	100	100	100	100

Percentages of Total (age-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_AGE(5)

	<30	30-40	40-50	50-60	>60	Total
EXCELLEN	9.888579	16.29526	8.844011	6.197772	2.019499	43.24513
GOOD	6.476323	11.62953	13.09192	7.799443	2.785515	41.78273
ACCEPTAB	0.696379	3.62117	2.437326	3.064067	0.696379	10.51532
BAD	0.208914	0.348189	0.417827	1.462396	0.069638	2.506964
POOR	0.278552	0.557103	0.417827	0.557103	0.139276	1.949861
Total	17.54875	32.45125	25.20891	19.08078	5.710306	100

Expected Frequencies (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR	Total
EXCELLEN	178.0209	300.6284	106.8998	33.59708	7.853862	627
GOOD	170.071	287.2032	102.126	32.09673	7.503132	599
ACCEPTAB	42.3048	71.4412	25.40362	7.983994	1.866388	149
BAD	10.22129	17.26096	6.137787	1.929019	0.450939	36
POOR	7.382046	12.46625	4.432846	1.39318	0.325678	26
Total	408	689	245	77	18	1437

Observed minus Expected Frequencies (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR
EXCELLEN	141.9791	-37.62839	-68.89979	-27.59708	-7.853862
GOOD	-88.07098	84.7968	5.874043	-0.096729	-2.503132
ACCEPTAB	-37.3048	-27.4412	52.59638	8.016006	4.133612
BAD	-9.221294	-11.26096	5.862213	14.07098	0.549061
POOR	-7.382046	-8.466249	4.567154	5.60682	5.674322

Contributions to Chi-Square (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR	Total
EXCELLEN	113.2343	4.709788	44.40777	22.6686	7.853862	192.8743
GOOD	45.60741	25.03627	0.337861	0.000292	0.835074	71.81691
ACCEPTAB	32.89575	10.54041	108.8971	8.048145	9.154979	169.5363
BAD	8.319129	7.346592	5.599012	102.639	0.668532	124.5722
POOR	7.382046	5.749715	4.705531	22.56451	98.86414	139.2659
Total	207.4387	53.38277	163.9472	155.9205	117.3766	698.0658

Standardized Deviates (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR	Total
EXCELLEN	10.64116	-2.170205	-6.663915	-4.761155	-2.802474	-5.756588
GOOD	-6.753326	5.003626	0.581258	-0.017074	-0.913824	-2.09934
ACCEPTAB	-5.735482	-3.246599	10.43538	2.836925	3.02572	7.315939
BAD	-2.88429	-2.71046	2.366223	10.13109	0.817638	7.720201
POOR	-2.716992	-2.397856	2.169224	4.750211	9.943045	11.74763
Total	-7.448929	-5.521494	8.888165	12.94	10.0701	18.92784

Percentages of Row Totals (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR	Total
EXCELLEN	51.03668	41.94577	6.060606	0.956938	0	100
GOOD	13.68948	62.10351	18.03005	5.342237	0.834725	100
ACCEPTAB	3.355705	29.5302	52.34899	10.73826	4.026846	100
BAD	2.777778	16.66667	33.33333	44.44444	2.777778	100
POOR	0	15.38462	34.61538	26.92308	23.07692	100

Percentages of Column Totals (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR
EXCELLEN	78.43137	38.17126	15.5102	7.792208	0
GOOD	20.09804	53.99129	44.08163	41.55844	27.77778
ACCEPTAB	1.22549	6.386067	31.83673	20.77922	33.33333
BAD	0.245098	0.870827	4.897959	20.77922	5.555556
POOR	0	0.580552	3.673469	9.090909	33.33333
Total	100	100	100	100	100

Percentages of Total (cond-performance.sta)
Row variables: DRV_PER(5)
Column variables: VEH_COND(5)

	EXCELLEN	GOOD	ACCEPTAI	BAD	POOR	Total
EXCELLEN	22.26862	18.30202	2.644398	0.417537	0	43.63257
GOOD	5.706333	25.88727	7.515658	2.226862	0.347947	41.68406
ACCEPTAB	0.347947	3.061935	5.427975	1.113431	0.417537	10.36882
BAD	0.069589	0.417537	0.835073	1.113431	0.069589	2.505219
POOR	0	0.278358	0.626305	0.487126	0.417537	1.809325
Total	28.39248	47.94711	17.04941	5.358386	1.25261	100

Expected Frequencies (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS	Total
EXCELLEN	282.9605	23.9282	42.53902	13.29344	2.278876	365
GOOD	331.025	27.99272	49.76483	15.55151	2.665973	427
ACCEPTAB	91.47763	7.735692	13.75234	4.297607	0.736733	118
BAD	24.80749	2.097815	3.729448	1.165453	0.199792	32
POOR	14.72945	1.245578	2.21436	0.691988	0.118626	19
Total	745	63	112	35	6	961

Observed minus Expected Frequencies (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS
EXCELLEN	17.03954	0.0718	-14.53902	-1.293444	-1.278876
GOOD	-17.02497	6.007284	10.23517	2.448491	-1.665973
ACCEPTAB	-3.477627	-3.735692	5.247659	0.702393	1.263267
BAD	1.192508	-1.097815	-0.729448	-1.165453	1.800208
POOR	2.270552	-1.245578	-0.21436	-0.691988	-0.118626

Contributions to Chi-Square (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS	Total
EXCELLEN	1.026101	0.000215	4.969159	0.125851	0.717689	6.839016
GOOD	0.875613	1.289173	2.105076	0.3855	1.041071	5.696433
ACCEPTAB	0.132206	1.804027	2.002417	0.114798	2.166111	6.219559
BAD	0.057324	0.574501	0.142674	1.165453	16.22063	18.16058
POOR	0.350007	1.245578	0.020751	0.691988	0.118626	2.426949
Total	2.441251	4.913494	9.240077	2.48359	20.26412	39.34253

Standardized Deviates (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS	Total
EXCELLEN	1.012966	0.014678	-2.229161	-0.354755	-0.847165	-2.403437
GOOD	-0.935742	1.135418	1.450888	0.620887	-1.020329	1.251122
ACCEPTAB	-0.363601	-1.343141	1.415068	0.338818	1.471771	1.518916
BAD	0.239425	-0.757959	-0.377722	-1.079561	4.027484	2.051667
POOR	0.591614	-1.116054	-0.144052	-0.831858	-0.344422	-1.844773
Total	0.544662	-2.067058	0.115021	-1.30647	3.287339	0.573494

Percentages of Row Totals (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS	Total
EXCELLEN	82.19178	6.575342	7.671233	3.287671	0.273973	100
GOOD	73.5363	7.962529	14.05152	4.215457	0.234192	100
ACCEPTAB	74.57627	3.389831	16.10169	4.237288	1.694915	100
BAD	81.25	3.125	9.375	0	6.25	100
POOR	89.47368	0	10.52632	0	0	100

Percentages of Column Totals (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS
EXCELLEN	40.26846	38.09524	25	34.28571	16.66667
GOOD	42.14765	53.96825	53.57143	51.42857	16.66667
ACCEPTAB	11.81208	6.349206	16.96429	14.28571	33.33333
BAD	3.489933	1.587302	2.678571	0	33.33333
POOR	2.281879	0	1.785714	0	0
Total	100	100	100	100	100

Percentages of Total (nation-performance.sta)
Row variables: DRV_PER(5)
Column variables: NATIONAL(5)

	SAUDI	ARAB	ASIAN	FAREAST	OTHERS	Total
EXCELLEN	31.21748	2.497399	2.913632	1.248699	0.104058	37.98127
GOOD	32.6743	3.537981	6.243496	1.873049	0.104058	44.43288
ACCEPTAB	9.157128	0.416233	1.977107	0.520291	0.208117	12.27888
BAD	2.705515	0.104058	0.312175	0	0.208117	3.329865
POOR	1.768991	0	0.208117	0	0	1.977107
Total	77.52341	6.555671	11.65453	3.64204	0.62435	100

Expected Frequencies (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES	Total
EXCELLEN	100.3155	513.6845	614
GOOD	96.72113	495.2789	592
ACCEPTAB	24.8338	127.1662	152
BAD	5.88169	30.11831	36
POOR	4.247887	21.75211	26
Total	232	1188	1420

Observed minus Expected Frequencies (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES
EXCELLEN	-39.31549	39.31549
GOOD	15.27887	-15.27887
ACCEPTAB	11.1662	-11.1662
BAD	1.11831	-1.11831
POOR	11.75211	-11.75211

Contributions to Chi-Square (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES	Total
EXCELLEN	15.40847	3.009061	18.41753
GOOD	2.413578	0.471338	2.884916
ACCEPTAB	5.020736	0.98048	6.001216
BAD	0.212629	0.041523	0.254152
POOR	32.51314	6.349367	38.86251
Total	55.56855	10.85177	66.42032

Standardized Deviates (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES	Total
EXCELLEN	-3.925362	1.734665	-2.190698
GOOD	1.553569	-0.686541	0.867028
ACCEPTAB	2.2407	-0.990192	1.250508
BAD	0.461117	-0.203773	0.257344
POOR	5.702029	-2.519795	3.182234
Total	6.032053	-2.665637	3.366417

Percentages of Row Totals (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES	Total
EXCELLEN	9.934853	90.06515	100
GOOD	18.91892	81.08108	100
ACCEPTAB	23.68421	76.31579	100
BAD	19.44444	80.55556	100
POOR	61.53846	38.46154	100

Percentages of Column Totals (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES
EXCELLEN	26.2931	46.54882
GOOD	48.27586	40.40404
ACCEPTAB	15.51724	9.76431
BAD	3.017241	2.441077
POOR	6.896552	0.841751
Total	100	100

Percentages of Total (owner-performance.sta)
Row variables: DRV_PER(5)
Column variables: DRV_OWNR(2)

	NO	YES	Total
EXCELLEN	4.295775	38.94366	43.23944
GOOD	7.887324	33.80282	41.69014
ACCEPTAB	2.535211	8.169014	10.70423
BAD	0.492958	2.042254	2.535211
POOR	1.126761	0.704225	1.830986
Total	16.33803	83.66197	100

VITAE

Zeeshan Raza Abdy was born in Karachi, Pakistan. After Graduating from Secondary School he enrolled for Bachelor of Engineering at **N.E.D University**, Karachi. In May 1999, He graduated with **First Honors** in University for **Bachelor of Engineering**. Then he joined NESPAK (**Junior Geometrics Engineer,** *Karachi*, 2 month) , A.A. Associates (**Junior Structural Engineer,** *Karachi*, 1 month) and finally Pakroads (**Geometric Engineer** *Islamabad*, 6 month). In March 2003, He secured **MS Degree** in Civil Engineering, with **First Honors**, from **King Fahd University of Petroleum & Minerals**, Dhahran, Saudi Arabia.