Relationship between the noncompliance behavior at signalized intersection an driver characteristics.

Fayyaz ahmed. Siddiqui

Civil Engineering

June 1997

Abstract

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Finally some recommendations were made for the reduction of noncompliance at signalized intersections.

Relationship between the Noncompliance Behavior at Signalized Intersection and Driver Characteristics

by

Fayyaz Ahmed Siddiqui

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CIVIL ENGINEERING

June, 1997

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Relationship Between The Noncompliance Behavior At Signalized Intersection And Driver Characteristics

FAYYAZ AHMED SIDDIQUI

CIVIL ENGINEERING

June, 1997

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

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كلية الدراسات العليا
COLLEGE OF GRADUATE STUDIES

Dedicated To

my Parents

&

my Brothers and Sisters

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Abstract

Name: **Fayyaz Ahmed Siddiqui**

Title: **Relationship between the Noncompliance Behavior at Signalized Intersection and Driver Characteristics**

Major Field: **Civil Engineering**

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Traffic accidents at intersections are a very serious problem. They constitute about 50% of all urban accidents. Human factors are one of the major cause of these accidents. Hence a clear understanding of the relationships between socio-economic and attitudinal characteristics of drivers and their violation involvement is essential.

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It was found that violation frequencies in Eastern Province are very high as compared to violation frequencies in USA. Provision of left turn lane, provision of pedestrian crossing and improvement in sight distance reduce the violation frequencies significantly. The driving attitudes of drivers in Eastern Province were grouped in to four main attitudes by means of factor analysis of attitudes. The mean factor scores of these four groups suggested that there is no significant difference between the attitudes of red light violators and the attitudes of non violators in the Eastern province of Saudi Arabia.

Finally some recommendations were made for the reduction of noncompliance at signalized intersections.

MASTER OF SCIENCE DEGREE

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
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June, 1997

الخلاصه

الاسم : فياض احمد صديقي
عنوان الرسالـه : دراسة سلوكيات والصفات الشخصيه للسائقين الغير متقيدين بالإشارة المرورية الحمراء .
التخصـــــص : الهندسه المدنية
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تعتبر حوادث المرور عند تقاطعات الطرق حوادث خطيره جداً حيث تشكل ٥٠٪ من الحوادث في المدن وإن احد الاسباب الرئيسيه لهذه الحوادث هوالعوامل السلوكيه لقائد المركبات وذلك مما يجعل فهم العلاقه بين الخصائص النفسيه والاجتماعيه لقائدي المركبات غير المتقيدين بالإشاره الحمراء من الامور الضروريه .

موضوع هذه الدراسه هو تحديد انواع ومدى تكرار المخالفات المرورية عند التقاطعات ذات الاشارات المروريه في المنطقه الشرقيه ، وبحث العلاقه بين عدم التقيد بالاشارات المروريه عند التقاطعات وخصائص قائدي المركبات ولقد أجريت الدراسه عن طريق المسح الميداني في خمسة مواقع مختلفه في المنطقه الشرقيه وشملت مقابلات شخصيه على جانب الطرق لغير الملتزمين بالإشارات المروريه وكذلك بعض المتقيدين بالإ شارات المروريه .

لقد لوحظ بأن تكرار المخالفات في المنطقه الشرقيه مرتفع جداً إذا ما قورن بتكرار المخالفات في الولايات المتحده . كما لوحظ أنخفاض واضح في تكرار المخالفات إذا ما تم عمل مسار إنعطاف الى اليسار ، وإعطاء الاولويه لعبور المشاه وتأمين مسافة كافيه لتحسين الرؤية .

صنفت اتجاهات قائدي المركبات في المنطقه الشرقيه بواسطة التحليل العاملى الى أربعه اتجاهات رئيسيه ولم تظهر العوامل الاربعه وجود فروق احصائيه ذات دلاله بين اتجاهات غير المتقيدين بالاشاره الحمراء والمتقيدين في المنطقه الشرقيه في المملكه العربيه السعوديه .
ولقد تضمنت الدراسه بعض التوصيات للحد من المخالفات عند التقاطعات ذات الاشاره المروريه .

درجة الماجستير في العلوم
جامعة الملك فهد للبترول والمعادن
الظهران – المملكه العربيه السعوديه
يونيو ١٩٩٧

Chapter 1

Introduction

1.1 General

Motorization has increased very rapidly in Saudi Arabia. At the beginning of 1970 (1390 A.H.), there were approximately 100,000 vehicles in the country. Today the total number of vehicles is more than 6 million (Statistical Year Book, 1995), and the number of vehicles per capita approximates that of many European countries. However, the increase in vehicle usage that took place over nearly a century in Europe, occurred in 2.5 decades in the kingdom as shown in Figure 1.1.

With each passing day, in every country in the world, traffic accidents inflict a staggering amount of destruction. The toll, country loss of life and limb plus the socio-economic costs to society, is high and getting higher. Traffic accident is not simply a loss of a life but it is an unrecoverable setback to all those concerned. Each year millions of persons are killed or seriously injured in motor vehicle accidents. In Saudi Arabia, during1994-95 (1415 A.H.) more than 3,700 people died in traffic accidents and another 31,000 person suffered seriously disabling injuries in more than 122,000 traffic accidents (Statistical year Book, 1995). Traffic accidents are one of

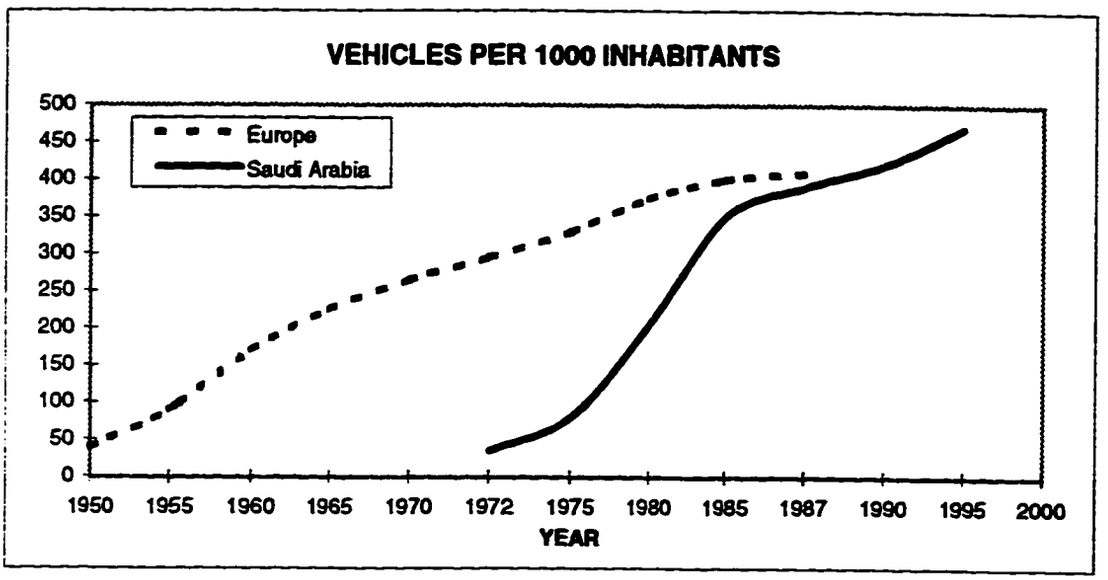

Figure 1.1: Comparison of autos increment between Saudi Arabia and West Europe.
Source: Traffic Engineering and Safety (1995) vol 5 pp.3.

the major causes of death in Saudi Arabia. Approximately 10% of the total deaths are because of traffic accidents (Statistical year Book, 1995).

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 for persons aged 1 to 37.

Traffic accidents at urban intersection are a very serious problem. They constitute about 50 percent of all urban accidents in USA (American City and County, 1992). This is not surprising because intersections are where traffic crosses, turns made and drivers have to judge speeds of approaching vehicles and decide when to go. Ergun (1988) estimated that in Saudi Arabia, accident rates are four to five times greater than those of the industrialized countries.

The transportation system consists of three elements; the environment (roads and signals), vehicles and people (driver and pedestrian). In our road-car-driver-pedestrian system the driver/pedestrian is the only decision making component and therefore it is his action or inaction that make this system go.

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 own car's behavior, make decisions about appropriate control actions, execute these actions and observe and respond to the new situation that results. It is believed that drivers are the main contributors to accidents (Pignataro, 1973).

Inappropriate driving behavior can result in unsafe driving conditions and increased accident potential. Such a behavior could result from ignorance, apathy, impatience, thrill seeking, or the desire to save time. Driving is a skill which is

learned, and judgment comes only with experience, so that it would seem self evident that the inexperienced will be at greater risk. Also those who drive higher mileage or have driven longer are more exposed to risk and might be expected to commit more motoring offenses and this violation may lead to accident.

1.2 Problem Statement

Motorist disregard of traffic control devices (TCDs) is of growing concern to those involved in traffic engineering and roadway safety. Driver noncompliance with traffic control devices, especially regulatory control devices has been increasing significantly over the years. The driver noncompliance with traffic rules and regulations contributes significantly to the problem of road accidents. Koushki and Ghadeer (1993) found that high approach speed and noncompliance with traffic signals at intersections are the major cause of these accidents at intersections in Saudi Arabia.

Drivers tend to over estimate their own ability and the capability of their vehicles. Certain inappropriate driving behaviors can result in unsafe driving conditions and increased accident potential. Drivers may or may not be aware that these behaviors can be hazardous or they may not perceive the seriousness of the potential consequences should an accident result. This is a situation that make research in the area of traffic safety an urgent priority.

1.3 Goals And Objectives

The main goal of this study is to determine the type and frequency of violation at signalized intersections in Eastern Province and to investigate the relationship between the magnitude of driver noncompliance at signalized intersections and driver characteristics. To achieve the general goal, the following specific objectives are targeted:

1. study the type of violations at signalized intersections,

2. study the relationships between traffic violations and geometric characteristics,

3. study the characteristics of violators at traffic signals,

4. establish relationships between the violations and the characteristics of the violators through statistical analysis,

5. make recommendations for the improvement of driving safety based upon the above findings.

Chapter 2

Literature Review

2.1 Traffic Signals and Their Effect on Safety

Traffic signal control alternates the right of way at an intersections to promote the orderly movement of vehicular and pedestrian traffic prevent excessive delay to waiting traffic and decrease the likelihood of accidents. Traffic signals must always be easily and readily recognized by the road user and their meaning must be clearly understood. To achieve this objective, traffic signals should be uniform, and compliance with requirement for obedience to the signal indication should be legally enforceable. When justified and properly designed a traffic signal installation may: (Manual of Transportation Engineering Studies, 1994).

- reduce the frequency of certain type of accidents,
- effect orderly traffic movement,
- provide for the continuous flow of a platoon of traffic through proper coordination at a definite speed along a given route,

- allow other vehicles and pedestrians to cross a heavy traffic stream,
- control traffic more economically than by manual methods.

Traffic signals do not always have a positive effect on roadway operations. An unjustified, poorly designed, improperly operated, or poorly maintained traffic signal may result in increased violation frequencies, increased accident frequencies, excessive delay, motorist disregard, decreased capacity, and circuitous travel by alternative routes. Parson (1995) argued that experience has indicated that although the installation of signals may result in a decrease in the number of right angle collision, there may be an increase in the number of rear-end collision.

The safety effects of signals have been examined more than those of other TCDs. For example, Parson study of 67 intersections at Michigan area, that had no geometric changes either during or after signal installations, showed that the total accident rate was reduced by 15%, enough to statistically significant. The injury accident rate, however, was reduced by only 7%, not a significant drop. Datta and Dutta (1990) reviewed the literature on installation of signals at intersections and reported that most studies find a decrease in right angle accidents. In their own work Datta and Dutta studied 102 intersections before and after signals were installed, they found patterns similar to those found by others. Rear-end collisions were 53% higher and head-on, left turn accidents, 50% higher, while right angle accidents 57% lower after installation. These findings raise the question of driver behavior while approaching a signalized intersections when the light changes.

2.2 Driver Noncompliance At Signalized Intersections

A signalized intersection is one of the complex locations in a traffic system. Hall and Hartado (1993) concluded that more than half of all traffic accidents happen at intersections or junctions where two roads come together. This is not surprising because intersections are the locations where traffic crosses each other turns are made and drivers have to judge speeds of approaching vehicles and decide when to go.

Traffic signals offer potential for accident reduction by segregating the movements of vehicles making conflicting maneuvers, but this potential is undermined by drivers who violate the signal. The noncompliance at signals may result from the combined effects of human behavior and traffic operational characteristics. Such human factors might include the driver age, vision, and perceived travel time (Mason et al. 1992, and Stoplin and Fisk 1991). Gordon and Robertson (1990) concluded that highway geometrics and traffic operation characteristics such as volume, type of regulatory control and speed may also affect driver noncompliance.

The documentation of driver violations of traffic control devices in Saudi Arabia only dates back to 1984 (Traffic violation statistics). Analysis of these statistics, however, showed that the number of traffic violations nationwide increased by more than 260 percent over the 6 year (1984-1989) period. During the same time period, the number of reported road accidents increased by 23 percent. However, official statistics in Saudi Arabia do not necessarily provide an accurate picture.

Koushki and Ghadeer (1993) studied 16 intersections in Riyadh and Buraidah, and they concluded that nighttime was the period with the highest rate of violation. Off peak hour as were second, and morning peak hours had the lowest rates. Lower traffic volumes, more relaxed enforcement during the night, and driver exhaustion after a long day's work may be the main causes for the higher violation rates during off peak and nighttime hours. In another study, Gordon and Robertson (1990) studied driver noncompliance with traffic signal at 12 intersections in Virginia, Maryland, and the District of Columbia. They observed drivers under various operational conditions at signalized intersections during the peak and off-peak, day and nighttime hours. They found that most violations occurred on low AADT (Annual Average Daily Traffic) volume intersection approaches. Similar results presented by Hall and Margarita (1993), they conclude that accident rates are highest at night, when traffic flows are relatively low. This may be due to sleepy or impaired drivers and the difficulties of driving in the darkness.

Speed limits are intended to inform drivers of the maximum reasonable and safe travel speed. However, there is little agreement on what constitutes a safe speed. Samuel and Warren (1990) stated that properly established speed limits foster voluntary compliance and separate the occasional high risk driver from vast majority of drivers.

2.3 Characteristics Of Violators

Early research on psychology of the driver showed consistent accident repeaters to be a small part of the problem (though special treatment for such groups

is important). By and large the largest share of traffic accidents is experienced by drivers who have one accident only. These mishaps involve misjudgments or lapses of the normal driver and a combination of causal factors which overload a drivers ability. The accident and motoring offense are both complex phenomena embracing characteristics associated with the driver.

Traffic accident can be attributed to human, vehicular and environmental factors. Ergun et al. (1988) investigated the safety problems in Saudi Arabia. They found that when considered alone, human factors account for about 57 percent and when together with the other factors (vehicle and environment) about 92%, of automobile accidents. Therefore, it is important that a clear understanding of the relationship between the socio-economic and attitudinal characteristics of drivers and accident involvement is obtained.

A knowledge of standards of driver behavior would help to determine which aspects of such behavior especially need to be improved. If these standards were assessed periodically, it would be possible to assess whether driver behavior was or was not improving and assess the effect of policies directed to the improvement of driver behavior.

Hedlund (1984) studied the United States fatalities rate from 1980 to 1983 and found that traffic fatalities in U.S. dropped 17 percent during this period. A drop of this size is most unusual, especially since there was little change in the people, vehicles, and roads, which form traffic system and since overall traffic rose 8%. He suggested that the drop resulted from behavioral change.

In Japan during the period 1970 to 1979 the reduction of road accident reduction was drastic. The fatalities were halved, while total travel increased 1.7 times during the same period. Koshi (1984) mentioned that the accident reduction in the 1970's was largely attributed to improvements of the environment of road users rather than improvement of the road users themselves. But the trend in 1980's however, indicates a gradual but obvious increase despite the continuous efforts at accident prevention. The only remedy left for future accident decrease is to improve behaviors of road users, especially drivers.

A number of studies have measured general attitudes towards a variety of transportation aspects. Several of these studies have applied attitudes to a wider scope than violation. A commonly accepted concept in the accident field is that " A man works (or drives, or plays) as he lives". A hostile, aggressive, impulsive, individual plays in situation that requires a constant attention, self control, consideration of others, and respect of laws and regulation such as in the driving of an automobile is more susceptible to having an accident.

As the human organism is fundamentally social in nature, it is probably difficult to find instances of road user behavior that are completely free from any form of social influence. Accident rates are known to be associated to a variety of social factors. We know very little about the causal factors related to accidents to some extent this dearth of knowledge may be attributed to a fatalistic view of accidents as chance events beyond scientific understanding and control.

2.3.1 Effect of 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 middle aged group.

There is considerable amount of evidence from both American and British studies that those aged under 20 are involved in and are blamed for a disproportionate number of accidents of all types, and that those aged between 20 and 30 are also over represented in accidents.

Calvin (1993) concluded that young novice drivers are severely over represented in traffic crashes. Driver 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 one-half times as likely to be in a fatal crash in which they have been drinking as the average driver. They are twice as likely to be in a fatal crash than the 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) argued that the young male drivers has the best vision, the quickest reactions and often the best driving skill of all drivers and he knows it. But

he also has a reputation for having the worst accident figures of all drivers groups. Why? It is not an effect of not knowing where the difficulties in traffic are. This seems to be fairly independent of the amount of driver experience. Spolander concluded that it is probably because he underestimates the difficulties or overestimates his own capacity or both, this results in very aggressive driving. Spolander further argued that the driving skill of women of the same age (biological and license), mainly due to more limited driving experience, probably is worse then that of men. But they drive more defensively and therefore, the accident risk of these two groups is roughly the same.

Brower et al.(1991) summarized the different studies related to older drivers. They found that older drivers are over represented in crashes when turning, in particular when turning left. They are also more frequently at fault in these crashes than are other age groups, often failing to yield the right of way violating instructions posted of traffic signs.

2.3.2 Occupation

So far, there exists little conclusive data regarding the relationship between occupation and accident involvement. This may be due to the interaction between occupation and other variables such as age, education and socioeconomic level. Mcmillian's study (1975) reported no significant relationship between the behaviors of drivers of different occupations. In another study, Suchman (1970) found statistically no significant differences in accident rates for variables such as the

family's financial status, the father's occupation and education or the students religion, residence and grade in school.

Coppin and Oldenbeek (1966) studied the California driver record of negligent drivers, they found that annual mileage is a factor that would be dangerous to ignore. The annual mileage of the negligent drivers was found to vary significantly with age, sex and occupation, and they drove nearly twice the annual mileage of a random sample of California drivers.

2.3.3 Education

Highway safety can be increased by improving any one of the three major components of the highway traffic system: the vehicles, the roadway environment, and the road user, typically the driver. Driver improvements begins even before licensing a person to drive, at the driver education stage.

Responsible agencies have recently been making efforts to reduce the traffic accident rate in the Kingdom. However, most of the improvement measures have been directed toward the road network component of the traffic system. Although it is expected that these measures will be very effective in reducing traffic accident there is still room for improving the driver behavior. The drivers themselves are at fault in the vast majority of accidents in the Kingdom, possibly because of their lack of sufficient driver education.

Driver education works, but there must be a commitment if it is to be fully effective. U.S. department of Transportation (1975) studied the effect of education on traffic accidents. They indicated that accident involvement decreases with higher

educational levels. The effectiveness of driver education in terms of accident reduction has been subjected to various tests. They also indicated that students completing a high school driver education program had as much as 50 percent fewer accidents than non graduates, that courses containing on-the-road training were more effective than classroom-only courses, and high school courses were more effective than commercial or parent training.

Loft (1960) studied the effects of a driver education course on a driving knowledge and attitudes of high school seniors, he concluded that driver education and non driver education boys having scored high on the attitude scale had only a few involvement's in traffic accident. Further, boys and girls having completed a two part course in driver education possess desirable attitudes toward driving and adequate traffic and driving knowledge. Driver education is influential in reducing accidents and traffic violations for teenage drivers. In this study Loft also recommended that a study be made to show how driver education courses may be organized and presented to provide adequate attention to developing desirable attitudes.

Cushman (1986) pointed out that task of learning has been compounded by the growing size disparity of vehicles in the traffic mix, expansion in the number of front wheel drive vehicles, and the non user friendly positioning and spacing of information signs and warnings. Cushman further stated that

> "The reason we have driver education is that we still have too many traffic mishaps. Despite all the advancements in mechanical and civil engineering, enforcement, and vehicle inspection, we still have collisions that produce 1.7 million disabling injuries and about 45,000 death each year along with billions of dollars in property damage. We

> know that about 80 to 92 percent of the accidents are caused by human error. We know, too, that driver education graduates have fewer and less costly accidents as well as better violation records than those who have not taken a course. We also know that driver education graduates are more likely to wear safety belts and have fewer arrests for driving while intoxicated". (Cushman, 1986, p.7)

Cushman suggested that the best driver education courses are a full semester long. Their integrated curriculums offer traditional classroom learning experiences and on street practice driving, as well as simulated driving experience.

2.3.4 Income

Due to contradictory data, no strong conclusions were derived regarding the effect of different income status on accident involvement. However, Ergun et al. (1982) investigated the highway safety problem in Saudi Arabia and found that the low income drivers had higher accident rates then high income drivers. He also gave the reason that it happened because of poor maintenance of the vehicle by this type.

2.3.5 Martial Status

Generally speaking, married drivers have better driving records than single drivers. Burg (1986) concluded that this relationship tends to hold true for both males and females, at all age levels and whether or not exposure (miles driven) is taken into account.

Single drivers were found to be involved in more accidents than those who are married. This is attributed to the fact that married drivers usually drive more carefully as a result of their responsibilities towards their family members. Harrington and

Robin (1960) showed that single male drivers average almost twice as many speed violations as married males. Also, they always have a higher violations rates for all types of violations, compared to married people.

2.3.6 Driving Experience

Driving is a skill which is learned, and judgment comes only with experience, so that it would seem self evident that the inexperienced will be at greater risk. Also, those who are most exposed to risk because they drive higher mileage or have driven longer might be expected to commit more motoring offenses and have more accidents.

The driving task appears immeasurably complex, controlling acceleration an deceleration while maintaining proper position in the lane and at the same time watching out for other car, pedestrians, signs and signals. The complexity is reflected in the results of a study by McKnight and Adams (1970) who identified approximately 1500 different perceptual motor tasks that the driver must master in order to negotiate safely on our highways. By observing where on the road drivers look, it was found that novice drivers looked close in front of the vehicle and more to the right of the vehicles direction of travel than the experienced drivers. Summala and Naatanen (1974) found that even when specifically instructed to pay attention to the road signs, inexperienced driver missed significantly more signs than experienced drivers.

In car driving, after controlling the confounding effect of driver age, inexperience is still associated with higher accident involvement. The effect of

inexperience appears to be in terms of causing inadequate directional control. Shinar et al.(1978) found that inexperience drivers were almost seven times as likely to cause an accidents because of inadequate drivers control.

What can we say about the other extreme, the highly skilled and experience driver?(Williams & O'Neill,1974) found that registered race drivers are involved in more accidents and violations than normal drivers. This is probably because as we gain experience we tend to become overconfident and change our driving habits. The risks that are perceived by the novice drivers prevent them from making many of the truly risky maneuvers that the experienced driver often make. Thus, many of the benefits that we gain from our increased skills are offset by the higher risks that we take.

2.3.7 Speed

The deadliest of errors made by individual drivers is speed. This is true in every society but even more so in Saudi Arabia because it is compounded by the phenomenon known as "joy riding", reckless driving at high speed as a form of recreation. High speed driving is used by some people to release pressure from other matters and to have a sense of power, a sensation often based on misperception of the actual amount of control a driver has on a speeding car.

The choice of speed can be considered as possibly dependent on road design factors, vehicle design and driver characteristics. Speed limits are supposed to have a general effect on safety on the basis of two assumptions. The first is that speed limits reduce the mean speed, which implies that if an accident occurs, the impact forces

will be lower and consequently the severity of injury will be lower as well. Secondly, it is assumed that speed limit reduce the variability in speed choice, and that lower speed variability will reduce the probability of accident occurring.

Research in the UK has indicated that drivers who habitually drive close to the median cruising speed on a highway are less often involved in accidents that those drivers who tend to drive faster or those who drive slower (Wilde, 1966). Thus there is an evidence of a 'U' shaped relationship between accident probabilities and driving speeds.

Rothengatter and Bruin (1988) studied the influence of driver's attitudes and vehicle characteristics. They identified four motivational factors that can predict speed choice to a significant degree, these were labeled 'pleasure driving'; 'risk'; 'travel time' and 'travel cost'. Individuals driving cars with higher top speeds tend to drive faster than individuals with cars with lower top speeds because they regard this as more pleasurable, and are less concerned with the costs of driving.

2.3.8 Effect of Time

Carlson (1973) in his study of age, exposure and alcohol involvement in night crashes concluded that young drivers continue to have larger numbers of crashes than would be expected from their representation in the population. He noted that the high crash involvement of drivers aged 16 to 25 corresponds, to a high degree of night driving. Carlson suggested that in order to reduce the crash "costs" resulting from these accident patterns, it will probably be necessary to reduce nighttime driving.

Koushki and Ghadeer (1993) studied the different type of violations at Riyadh and Buraidah. They studied the violations at 16 different intersections and found that the violation rate for every violation category were higher during the nighttime periods, second highest during the off peak periods, and third highest during the peak periods. The details of all types of violation at Riyadh and Buraidah are given in Table 2.1.

It is clear from the table that the mean violation rates for the most dangerous type of signal violation of going through red (GTRVR) were 30 and 130 percent higher during the off peak daytime and nighttime periods, respectively, then during the combined morning and afternoon peak periods.

Gordon and Robertson (1990), studied the noncompliance with traffic signals at 12 intersections. They found that the not stopping on red (NOSTOP) mean violation rate was highest during the night time hours, second highest during off peak hours, and third and fourth highest during the morning and evening peak hours respectively.

The NRTOR (no right turn on red i.e., number of vehicles making a right turn on red when there is a "No Turn on Red" sign) mean violation rate was also highest during the night time hours, with the off peak hour second, evening peak hours, third, as shown in Table 2.2.

2.3.9 Aggressiveness

Poterfield (1960) characterizes motor vehicle which constitutes the most important single agent of accidental injuries and death as "Death Weapons" and sees

Table 2.1: Mean violation rates and time of the day.

Time of Day	Mean Violation Rates					
	GTRVR	RTRVR	SORVR	SOYVR	HASVR	TOTVR
			Riyadh			
Morning / Afternoon: Peak periods	1.00	14.3	0.70	0.62	0.28	16.90
Off-Peak Periods						
Daytime	1.30	16.3	0.76	0.86	0.52	19.74
Nighttime	2.30	21.1	1.18	1.22	0.94	26.74
			Buraidah			
Morning / Afternoon: Peak periods	0.80	7.8	0.64	0.76	0.60	10.6
Off-Peak Periods						
Daytime	0.82	8.2	0.74	0.68	0.70	11.3
Nighttime	1.16	8.9	0.85	0.98	0.80	12.7

GTRVR= Going through red violation rate
RTRVR= Right turn on red violation rate
SORVR= Starting on red violation rate
SOYVR= Speeding on yellow violation rate
HASVR= High approach speed violation rate

Source: Transportation Research Record 1168, pp 4.

Table 2.2: Time of the day violation rates.

Inter-	NOSTOP				NRTOR			
Section	Morning	Evening	Off Peak	Night	Morning	Evening	Off Peak	Night
1	-	-	-	12.54	1.97	2.46	2.21	-
2	2.75	2.75	1.78	5.48	-	-	-	-
3	3.35	3.17	17.55	9.43	1.92	0.00	0.89	-
4	4.08	2.99	4.60	14.09	0.56	1.05	2.09	7.23
5	1.65	4.11	5.79	18.01	-	-	-	-
6	3.49	3.50	2.83	-	-	-	-	-
7	8.98	8.58	10.12	-	-	-	-	-
8	15.42	14.38	15.61	39.71	-	-	-	-
9	18.92	6.30	10.18	20.39	-	-	-	-
10	6.80	4.00	11.03	7.45	-	-	-	-
11	-	-	-	-	2.84	2.12	1.72	4.79
12	26.25	10.28	21.95	16.47	-	-	-	-
Mean rate	6.51	5.43	8.54	13.14	1.34	1.61	1.79	5.89

Source: Transportation Research Record 1168, pp 5

them as reflection of an underlying social pathology. To some extent accidents, like suicides and homicides, may represent the socialization of aggression.

A number of studies designed to measure a wide range of personality traits have compared individuals whose accident frequency rate is high with those whose rate is low. While these studies shows wide variation in personality factor related to the frequency of accidents, there seems to be some agreement on the generally anti-social nature of the accident repeater. Schulzinger (1956) found that accidents were more likely to occur among aggressive individuals, especially among those who are "irresponsible-maladjusted".

2.3.10 Risk Taking Behavior

"Bad accident risks" are frequently unstable, immature, impulsive, aggressive, antisocial, self-centered, and overconfident, as well as being sometimes inadequate and in secure. "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 man the most willing to take risks.

Suchman (1966) studied the attitudes of high school students found that those students who are most favorably disposed towards "taking chances" are about four times as likely to have had more than one accident in the past year as those who are most opposed (26.9% vs. 6.2%). Similarly student who find "thrilling" to ride in a fast car are also more likely to have suffered accidental injury than those who do not have these attitudes.

He further found that, among high-school students, the more the individual describes himself as being 'wild, daring, or liking to show of', the more likely he is to report having had two or more accidents during the past year, in addition, the more careless he is and the more easily he losses his temper, the more likely he is to have being injured in an accident.

2.3.11 Aberrant Behavior

There is an indication in the post research that, on a behavioral level, accidents are closely associated with various indices of behavioral deviation. Suchman (1966), in summarizing the work of various authors, stated that individuals from broken homes are more likely to be involved in accidents, children in families with higher cohesion and belief in tradition were less likely to have accidents than children in families not so well integrated. He further stated that individuals who have frequent accidents are far more likely to have court records of law violation than individuals with fewer accidents.

Deviance may also be usefully applied to accident research. To the extent that the community has institutionalized certain safe modes of behavior, departures from these may be viewed as aberrant behavior. Suchman (1966) also viewed accidents as a form of deviant behavior and hypothesized that there is a threshold of conforming behavior beyond which an individual entered into accident inducing situation. These threshold are established by the social groups in terms of accepted patterns of safe and unsafe behavior repeated accidents may thus be a symptom of individual deviance

from a group of norm of safe behavior. Suchman also concluded that the more deviant the individual is, the more likely he is to have an accident.

2.3.12 Previous Violations

The violation of rules means a negative attitude towards traffic safety, and unwillingness to be concerned with other road users, or a willingness to accept a smaller safety margin. McMillan (1975) concluded that drivers with a previous history of traffic conviction and accidents, are on the average, more likely to be involved in subsequent accidents than are drivers with clean records.

2.3.13 Fatigue

Falling asleep while driving is the most extreme end result of fatigue. Driving may not require excessive muscular work, does require mental work. There is only one successful way to overcome the effect of fatigue, take a nap. When this is unrealistic, the driver can energize himself of herself, by continuously shifting his or her eyes from one side of the road to other, chewinggum, by singing, by opening window to let fresh air come in, and the like. Toaka (1993) 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 at the wheel.

2.3.14 Social Maladjustment

People who are socially maladjusted in other areas of life (based on their interactions with various public agencies) tend to be over involved in violating traffic laws and in causing accidents. Havilend and Wicemen (1974) who compared the driving records of 114 jailed criminals with those of the normal populations. The criminal driver was found to have, on the average, 3.25 times as many citation for traffic violations, and be involved in 19.5 times as many fatal accidents as the average non criminal driver. Furthermore, criminals who were involved in major traffic offenses, were likely to have been involved in major crimes, and those involved in minor traffic offenses in minor crimes, suggesting that the degree of individual's deviations from societal norms is similar in divergent areas. Those having repeated accidents or committing serious motoring offenses have a poor social adjustment. As a group they appear to be "out of step" with society, to be in conflict with authority in other ways and to need the support of social agencies.

2.3.15 Automobile Maintenance

Many auto crashes are the result of the driver psychopathology which translates it self into dangerous driving behavior but there may be further role caused by psychopathology in terms of poor auto maintenance. The National Safety Council of United States has estimated that 11% of all crashes are due to defective vehicle and other estimates are even higher. It has been noted that person with certain life styles, such as impulsive, irresponsible, and anti social personalities, exhibit risky driver

practices, Pokorny (1966) hypothesize that these characteristics might also lead to risk taking in terms of poor vehicle maintenance.

In each crash it is necessary to evaluate the extent to which any vehicle defect or malfunction has contributed to a particular crash. Pokorny (1966) found that 26 of the 34 study vehicles (76%) had one or more defect which were considered to be causative contributory to the crash. The most common causative defect was poor brakes and this was likewise the most contributory cause. Of the 21 automobiles with defective brakes, rated either causative or contributory, 19 had more than 45,000 miles on the odometer. This immediately raises the point that cars with this much mileage should have specific emphasis on brake inspection. Pokorny also found that vehicular system reflects personality disorders and the abnormal personality leads to poor vehicle maintenance and to poor driving. He further stated that, of those with abnormal personality disorders, significantly more received tickets for traffic violation in connection with the crash. In short, abnormal personality functioning contributes to auto crashes both through faulty driving and faulty vehicle maintenance.

2.3.16 Effect of Enforcement

Most well planned studies of enforcement have been concerned with its effects on driver behavior. The overwhelming majority of studies reviewed were concerned with speeding because it is the most common traffic offense, it can be detected more readily and positively than any other traffic offenses.

Armour (1984) summarized the different studies on traffic law enforcement and stated that the majority of studies concerned with driver behavior have been

interested in the immediate effect of traffic enforcement and only a few studies have attempted to consider the long term effects of enforcement. The most common measure used has been speed, but other aspects of driving behavior such as traffic signal and stop sign obedience have occasionally been used.

It is generally accepted that police law enforcement influences driving behavior. Police law enforcement influences offending drivers by booking them and then punishing or removing them from the traffic stream. On the other hand, police enforcement also influences general drivers because they think that traffic laws are being enforced and that a real risk of detection and punishment exists when traffic laws are broken.

Armour (1984) suggested that in order to influence community driving habits and provide general deterrence, it would seen logical that the police should maintain highly visible presence. It is possible that in addition to the halo effect of enforcement, there may also be a memory effect. That is , drivers may alter their behavior because they are in an area where they have previously, seen an enforcement vehicle or where enforcement vehicles are known to operate although they might not be apparent at the time.

To have an effect upon a driver's behavior, an individual enforcement unit must be seen as a threat for an enforcement unit to appear threatening, Shinar (1978) suggested that it must be visible, identifiable and prepared. Shinar studied the effect of enforcement and public information on compliance and suggested that law enforcement unit must be highly visible. The greatest visibility of law enforcement

were most effective in securing compliance with traffic laws. He suggested some specific techniques for maximizing visibility i.e.

- Remaining stationary in order to maximize exposure to drivers, rather than operating within the traffic stream.
- Parking vehicles in highly visible locations.

He further suggested that visible enforcement must appear threatening. Motorist must perceive an enforcement unit as being ready, willing and able to apprehend them before they will perceive themselves as being at risk.

Chapter 3

Methodology

This study was designed mainly to analyze the relationship between the non compliance behavior at signalized intersections and driver characteristics. To achieve this, certain apriori hypotheses were set and these were later on tested. To achieve the stated objective, this study was divided into two sub-studies, the first study was a 'Violation Study' in which violations at different intersections in the Eastern province were studied. The second study, was the 'Violator Study' in which characteristics of violator at different locations in the Eastern province were investigated by interviewing violators and non violators.

3.1 Violation Study

In this study, violation at different intersections were studied by field survey. The intersections were selected so as to cover the whole Eastern province. Twelve intersections were randomly selected from Eastern province covering Khobar, Dammam and Qatif area. The primary consideration, however, was that the selected

intersections should have some basic design elements which would be similar to intersections in other part of the Kingdom.

To achieve the stated objectives, the following steps were followed:

1. formulation of hypotheses,
2. definition of violation type,
3. determination of study duration,
4. experimental design,
5. selection of sample intersection,
6. pilot study,
7. data collection,

3.1.1 Research Hypotheses

It is hypothesized that there is a relationship between driver noncompliance with traffic signals at intersections with time of the day, volume of traffic, location(CBD and Fringe area), intersection geometry covering existence of exclusive left turning lane and number of lanes (1 or 2 lanes and 3 or more lanes) and the driver characteristics.

3.1.2 Definition of Violation Type

On the basis of review of literature and field observations, and keeping in view of research hypotheses six types of violation at signalized intersections have been defined.

1. Not Stopping On Yellow (NSOY) violation frequency; the number of vehicles speeding to go through the intersection during the yellow phase rather than stopping and waiting for the next, green phase.

2. Not Stopping on Red (NSOR) violation frequency; the number of through and left turning vehicles entering the intersection past the near curb line after the onset of the red signal indication.

3. Starting On Red (SOR) violation frequency; the number of vehicles starting to move before the completion of the red phase.

4. Right Turn on Red With Stop(RTRWS) violation frequency; the number of vehicles making a right turn on red with stop where such a turn is not permitted.

5. Right Turn on Red Without Stopping (RTRWOS) violation frequency, the number of vehicles making a right turn on red without stopping where such a turn is not permitted.

6. Total Number of Violations (TOTVIOL) frequency; the sum of above 5 violation types.

Violation rates will be calculated by dividing the number of violations per 100 vehicles of its corresponding traffic volume.

3.1.3 Study Duration

The following equation is used to determine the required duration (NT) of the study (Glauz and Migletz, 1980).

$$NT = [100\frac{Z}{PC}]^2 \frac{\sigma^2}{mean^2}$$

Where, NT = number of units of time that the traffic must be observed

Z = a constant corresponding to desired level of confidence (i.e. 90%)

PC = Permitted error in the estimate of mean conflict rate

σ^2 = expected variance of the noncompliance rate

mean = hourly mean value of red light violations.

For this study hourly mean and hourly variance values of noncompliance are needed. Koushki and Ghadeer (1993) conducted a study on driver noncompliance with traffic signals in Riyadh and Buraidah. The average mean was 13.5 violations per hour and the variance was 3.9 violations per hour for speeding on yellow violation. Speeding on yellow violation had a lower frequencies than going through red.

Mean = 13.5 violation/hour

Variance = 3.9 violation/hour

Z= 1.65 (for =0.10)

P=50%.

$NT = (100 * 1.65 / 50)^2 * 3.9^2 / 13.5^2$

NT = 0.91 hours $\simeq$1 hour.

To increase the confidence it was decided to do the study for one and a half hour at each selected location (approach).

3.1.4 Number of Intersection Approaches

The sample size needed can be determined using the formula. (Manual of Transportation Engineering studies,1994, p.229).

$$n = \frac{Z_{\frac{\alpha}{2}}^{2}\ \sigma^2}{E^2}$$

Where

n = Number of approaches

$Z_{\alpha/2}$ = normal random variable at 95% confidence level

σ^2 = expected variance of the noncompliance rate

E = permitted error in the estimation of noncompliance rate

Based on the study done in Riyadh and Buraidah by Koushki and Ghadeer (1993), The mean and standard deviation for speeding on yellow violation were 3.35 and 1.95 violations per hour per approach respectively. Thus, the size of the sample so that it gives the margin of error not greater than $\pm$ 1.68 (which is 50% of mean).

Therefore,

$n = 1.96^2 * (1.95)^2 / (1.65)^2$

n = 5.4 approaches $\cong$ 6 approaches.

3.1.5 Experimental Design

The violation counts and interviews were made in Khobar, Dammam and Al-Qatif area. An experimental design was aimed to study the effect of time (Peak, off peak and evening), location (CBD and fringe area) and intersection geometry covering existence of left turn lanes and number of lanes (1 or 2 and 3 or more lanes). With the calculated number of approaches as given above, and the factors mentioned above, a full factorial design was aimed as given in Table 3.1. For each cell a minimum of 6 approaches was aimed to be selected.

Table 3.1: Experimental design of violator study.

Approach Geometry	Number of Approaches	Location	
		CBD	Fringe
With Left Lane	3 or more lanes	6	6
	1 or 2 lanes	6	6
Without Left Lane	3 or more lanes	6	6
	1 or 2 lanes	6	6

However, it was not possible to find enough approaches with 3 or more lane without left-turn lanes. Therefore, the experimental design was modified and the line corresponding to these approaches were dropped as shown in Table 3.2. The study intersections were selected randomly from a list of candidate intersections in five areas within the Eastern province namely, Al-Augrabia, Khobar, Dammam Thouqba and Qatif. With these selected intersections, the number of approaches given in Table 3.2 were obtained. Each cell contained at least 6 approaches as per the sample size requirement calculated above.

Furthermore, each of these intersections were studied for 2 hr periods during off-peak (1:30 to 3:30 PM), peak (3:30 to 5:30 PM) and evening (5:30 to 7:30 PM).

3.1.6 Selection of Sample Intersections

Twelve intersections were selected from Eastern province covering Khobar, Dammam and Qatif area. The Primary consideration, however, was that the selected intersections should have some basic design elements which would be similar to intersections in other part of the Kingdom.

Based on the experimental design the selection of intersections were depend on a number of criteria, these include area type (CBD or fringe), number of approaches (four only), number of approach lanes, geometry of approaches (left turn lane exists or not exists) and volume of traffic. For this purpose a survey was conducted around Khobar, Dammam and Qatif area and a inventory of 60 intersections were made. Twelve intersections were selected from the list of possible

Table 3.2: Modified Experimental design of violator study.

Approach Geometry	Number of Approaches	Location	
		CBD	Fringe
With Left Lane	3 or more lanes	10	7
	1 or 2 lanes	6	8
Without Left Lane	1 or 2 lanes	8	6

locations (given in Table 3.3) on the basis of above criteria and time/budget resources of the project. In selecting the location, it was intend to cover the whole area. Six of the intersections were located in Khobar area, four were located in Dammam area and the rest of the two intersections were in Qatif area.

3.1.7 Pilot Study

A two hour pilot survey was conducted before the actual survey was started. The purposes of pilot study were to check:

- whether the number of surveyors are adequate
- the instruments used during the study
- whether each observer understand his job clearly or not.

For that purpose, each observer were assigned same things to measure during 15 minutes interval for two hours. The results of pilot study were used for testing the reliabilities of observers. The results were presented in Table 3.4.

As generally the reliabilities was very good. However, as seen from the table that the right and left volume count of observer number 3 for the 2nd interval did not match with the other observers but the total volume count is same. This was because the observer changed the tally board button during the counting period. To remedy this situation we used written tags on tally boards for every task afterwards.

Table 3.3: Detail of selected intersections.

S.No	Code	Intersection	Location	Area Type	Approach	No of thru lanes	Left Turn Lane
1	FK2	Riyadh Street	Thouqba	Fringe	1	2	Exist
	1	By			2	2	Exist
		15th Street.			3	2	Exist
					4	2	Exist
2	FK6	Al-Khobar Street	Thoqba	Fringe	1	2	Not Exist
		By			2	2	Not Exist
		20th Street			3	2	Not Exist
					4	2	Not Exist
3	FK8	Al-Amirhmoud St.	Augrabia	Fringe	1	3	Exist
		By			2	1	Exist
		4rth Street			3	3	Exist
					4	1	Exist
4	FD1	Ibn-Sina Street	Dammam	Fringe	1	3	Exist
		By			2	3	Exist
		1st Street			3	3	Not Exist
					4	3	Not Exist
5	FD3	Ibn-Khaldoon	Dammam	Fringe	1	3	Exist
		By			2	3	Not Exist
		1st Street			3	3	Exist
					4	3	Exist
6	FQ2	Jazira Street	Qatif	Fringe	1	2	Exist
		By			2	1	Not Exist
		Bader Street			3	2	Exist
					4	2	Not Exist
7	CK1	King Abdul Aziz St.	Khobar	CBD	1	3	Exist
		By			2	2	Exist
		28th Street			3	5	Exist

S.No	Code	Intersection	Location	Area Type	Approach	No of thru lanes	Left Turn Lane
					4	2	Exist
8	CK2	King Abdul Aziz St.	Khobar	CBD	1	3	Exist
		By			2	2	Exist
		22nd Street			3	3	Not Exist
					4	2	Not Exist
9	CK3	King Abdul Aziz St.	Khobar	CBD	1	3	Exist
		By			2	1	Exist
		16th Street			3	3	Exist
					4	1	Exist
10	CD1	King Khalid Street	Dammam	CBD	1	2	Exist
		By			2	2	Exist
		1st Street			3	2	Exist
					4	2	Exist
11	CD3	King Abdul Aziz	Dammam	CBD	1	3	Exist
		By			2	3	Exist
		1st Street			3	2	Exist
					4	2	Exist
12	CQ3	Qudssi Street	Qatif	CBD	1	3	Exist
		By			2	2	Exist
		Fateh Street			3	3	Exist
					4	1	Exist

Table 3.4: Testing the reliabilities of observers. Pilot study results
Intersection of Mecca with 4rth Street

Observer No	Total Volume				NSOY	NSOR	NSOR5SEC	SOR	RORWS	RORWOS	FREECH
	L	S	R	T							
First Interval											
Observer No 1	13	50	3	66	2	3	0	5	1	3	23
Observer No 2	13	51	3	67	2	3	0	5	1	2	24
Observer No 3	13	51	3	67	2	3	0	5	1	3	25
Observer No 4	13	51	3	67	2	3	0	7	1	3	22
Second Interval											
Observer No 1	18	83	3	104	1	0	0	5	0	4	26
Observer No 2	18	81	3	102	1	0	0	4	0	4	25
Observer No 3	10	83	11	104	1	0	0	5	0	4	25
Observer No 4	17	84	3	104	1	0	0	6	0	5	27

3.1.8 Data Collection

The data on physical and operational characteristics, traffic volume, traffic violations and approach speed were collected at each intersection by a 5 member team. All the intersections were operating with fixed time signal controllers, and had 4 phases. The intersections were studied during 7th-29th December 1996. The data were collected during the working days of week i.e. Saturday through Wednesday. Only weekdays were selected because the traffic pattern on weekends is very much different from that on weekdays and our experimental design does not include weekends. The time of observation was 1:30 PM to 7:30 PM. The data collected for each leg of intersection were:

a) traffic volume count (left, right and through).

b) traffic violation count (six types).

c) speed measurement.

d) signal timings i.e. (green time, yellow time, red time and signal cycle length)

e) operational and physical checklist of intersection.

f) rough sketch of intersection.

g) measurement of approach width and median width.

The time under which compliance studies were conducted can affect the results therefore, these studies were performed in good weather and normal conditions (i.e. there were no circumstances present that may affect the result). Dry pavement condition and fair temperatures prevailed during the monitoring period.

Traffic volume and traffic violations were collected for 2 hour periods during off peaks (1:30 to 3:30 PM), peaks (3:30 to 5:30 PM) and evenings (5:30 to 7:30 PM) for a total of 6 hour per intersection. At each intersection, traffic volume and violations were counted on a rotation of 15 minute intervals per approach for 6 hours. This provided 15 minutes sample volume and violations count per hour per approach. so for each of above 3 periods we have half hour readings. Hourly volumes were obtained by expanding the half hour of sample counts for each approach.

For monitoring large intersections with heavy traffic volumes, as many as six people were involved in the collection of data. The survey team mostly included the same trained individuals throughout the study period to ensure the consistency in the quality of the collected data. However, if some new survey member was included in the team, he was assigned either speed measurement or volume count. Survey team was comprised of graduate and undergraduate students mostly from civil engineering department.

Lectures were given about the objectives of this study to the survey team. Training included explaining the use of equipment and recording the data on the

prescribed forms. For violation observers, literature about the operational definitions of different types of traffic violation was given and explained.

There were generally 5 surveyors working on the intersection. one surveyor measured the approach speed, one surveyor measured the total volume count i.e. left, right and through volume. If volumes were high than he only measured either right and through or left and through volumes, the other observer take care of the left over side. Two surveyors measured six types of violations and vehicles whose drivers had a free choice of stopping or not stopping. One surveyor took the intersection inventory, measured the signal timings during off peaks, peaks, and evening periods, he was the group leader and also responsible for on site training for new surveyors, coordination among surveyors, made random checks on other surveyors, keep the time, recorded the data on data sheets, and finally transferred all the data on one sheet. The positions of surveyors are highlighted on Figure 3.1.

The surveys usually started at 1:30 PM and continued till 7:30 PM without any break. Six rounds of observations were taken each day. The first round usually was at 1:30 PM to 2:30 PM, the second round from 2:30 PM to 3:30 PM and so on till sixth round from 6:30 PM to 7:30 PM. Usually the survey begins with northbound approach. The period of observations was of 15 minutes per approach. Thus, at 1:45 PM, observation at northbound approach was completed. the observers recorded the volume and violations counts from tally board to prescribed forms and than moved counterclockwise to new position i.e. westbound approach. Thus, from 1:45 PM to 2:00 PM, they completed the observations on westbound approach. thus from 2:00

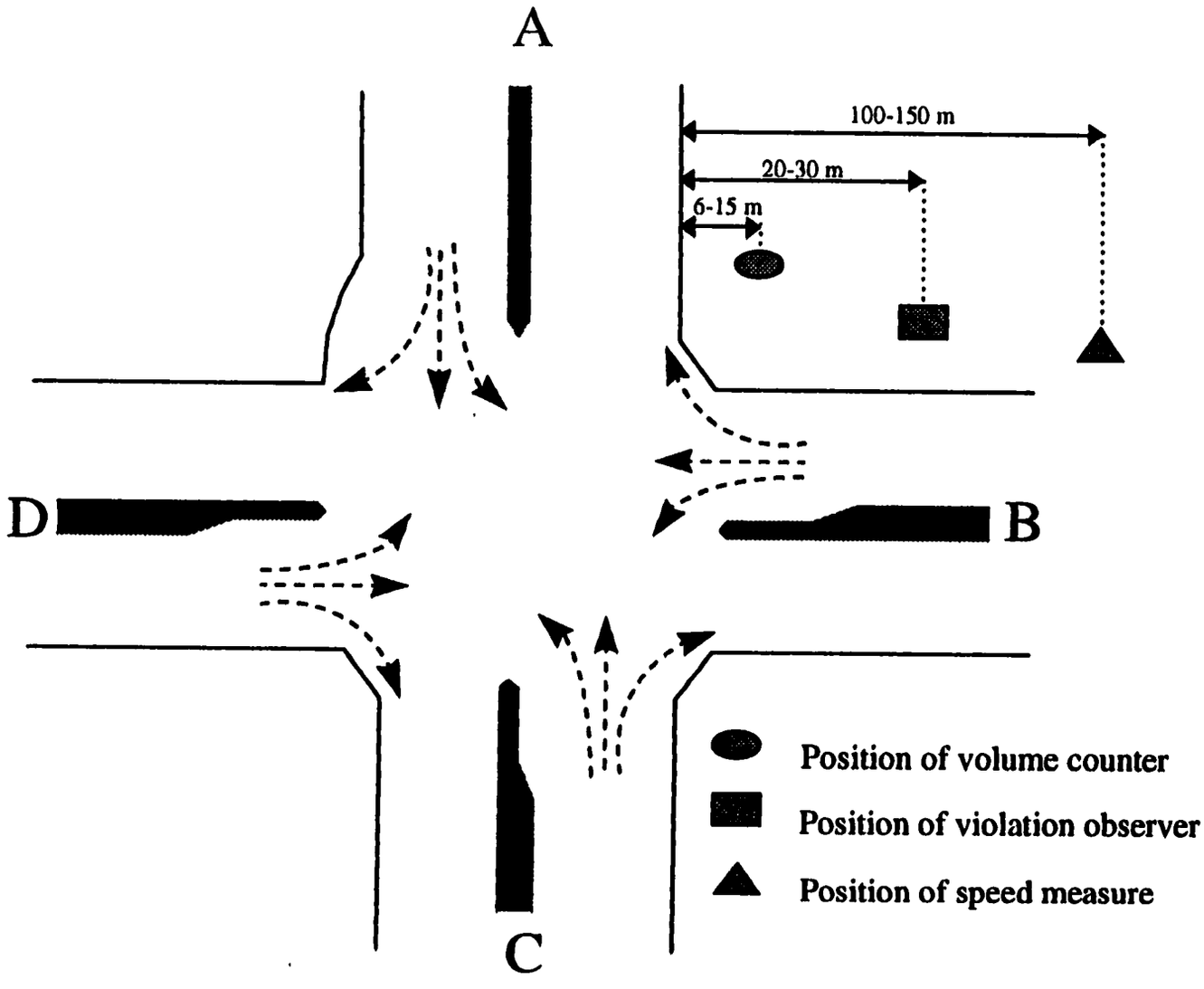

Figure 3.1: The position of violation observers, volume counters & speed measurer

PM to 2:15 PM they took observations at southbound approach and from 2:15 PM to 2:30 PM they covered eastbound approach. This completes one round of observation. Similarly second round was started from 2:30 PM from northbound approach and completed at eastbound approach at 3:30 PM. The timings are shown in Figure 3.2

The approach speed measurer usually stand about 100 to 150 m away from the signal. Sometimes his radar's direction was toward signal or sometime away from the signal depending upon his distance from the signal. If he stand more than 150 m away from the signal the direction of radar was toward signal and if he stand between 100 to 150 m the direction of speed measuring radar was opposite to the signal. When measurer measured the required number of vehicles i.e. 70 at northbound approach then he moved to westbound approach The observer measured the approach speed at four approaches during off peak, peak and evening time.

The equipment used was very simple. The violation observers and volume counters, used tally boards and stopwatches. The speed measurer used a speed measuring radar. For measuring approach width and median width, a wheel meter was used. The green, yellow, red times and cycle length of signal were recorded using electronic stop watch. The physical details of the intersections were also taken on specially designed form for this study. Necessary changes were made in the form after pilot study. The form is given in Appendix A.

3.2 Violator Study

One of the objectives of this study was to understand the social and physchological characteristics of the traffic violator. For this purpose an interview

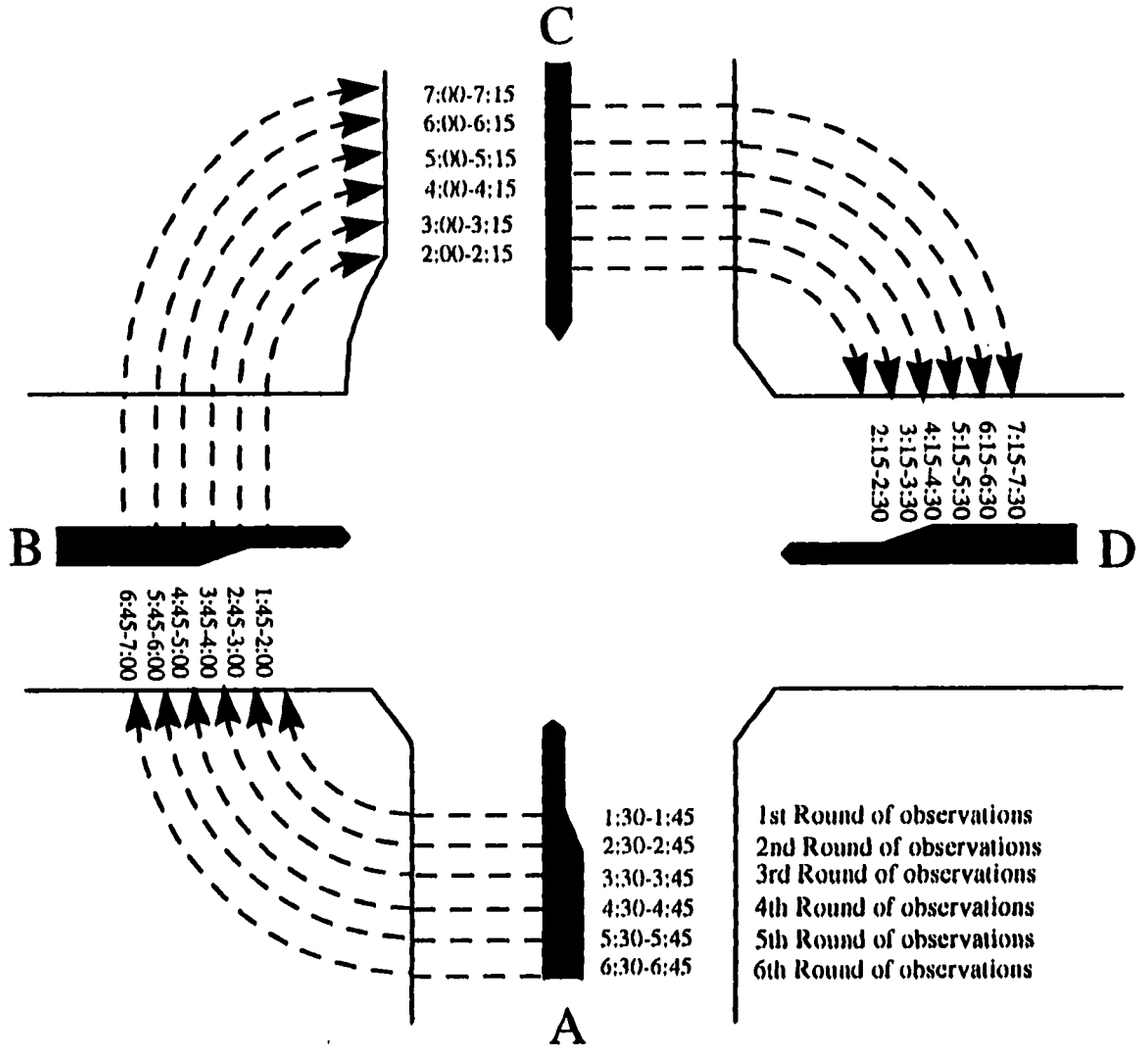

Figure 3.2: Time of observation and sequence for observers.

form (questionnaire) was developed. 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 instructions, 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.

3.2.1 Research Hypotheses

It is hypothesized that there is significant relationship between driver noncompliance at signalized intersections with his socio economic characteristics such as:

Age: Number of violations increase with age of drivers.

Nationality: Saudi's make more violations than non Saudi's.

Occupation: Blue collar workers make more violations than white collar ones.

Education: The number of violations decreases with higher education.

Driving Experience: Number of violations decreases with experience of driving.

Income: Number of violations decreases with the increase of income.

Driving School: The drivers who had training in a driving school will have less violations.

Kilometers Driven: Number of violations increases with number of kilometers driven.

Marital Status: Married people will have less violations than the unmarried ones.

3.2.2 Question Order

Research has shown that responses to a question can differ depending on placement of the question in relation to other questions. There are no rules on question order, but several general suggestions for obtaining higher quality responses include:

1. place easier questions early in the survey to avoid discouraging respondents,
2. place questions that may be threatening to respondents in the middle of the survey, (Sudman and Bradburn, 1982).
3. place demographic survey at the end of the survey. (Stopher and Meyberg),
4. avoid response set bias (a series of questions in a row with the same response),

Survey begin 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 rights and privileges.

3.2.3 Types of Questions

There are two basic types of questions. Closed questions present a fixed set of alternate answers to the respondent. Open questions allow the respondent to create his own answer.

A closed type of questionnaire was designed for this study which present a fixed set of alternate answers to respondent. Closed type of Questionnaire was preferred for several reasons. First, answers to a closed questions are ready for

analysis. Second, closed questions allow respondents a common frame of reference. Third, close questions aid respondent recall. Fourth, closed questions reduce the amount of writing required and save time of respondents and interviewer, which is very important in our case because this study was conducted at signalized intersections where there is continuous movement of traffic. Finally, closed questions are less taxing mentally, so respondent will provide higher quality answers with a higher response rate (Alerck & Settle, 1985).

Closed questions takes many forms "Yes or No" questions are common and simple to score. Checklist questions provide respondents with a list of possible responses, from which they may choose one or more items. The key to constructing unbiased checklist questions include:

1. List must include all possible answers.
2. The items must be mutually exclusive.
3. There should be more variation between items then within individual items.

"No opinion" or "Don't Know" options were offered on checklist to include all possible answers and to avoid bias (Converse and Presser, 1986).

Closed survey questions may provide scales to the respondents so that they can choose positions on a continuos spectrum of possibilities. In comparison to other forms of closed questions, scales may save space on a written survey or save time in an interview.

In this Questionnaire a Likert Scale is used. Likert Scale measure the degree to which respondents agree with a statement, and usually run from 1 = Strongly agree through 3 = Neutral or No opinion to 5 = Strongly disagree.

The following points were under consideration during the preparation of Questionnaire.

- make questions as short as possible,
- use standard demographic questions and terms,
- use simple word to make the questionnaire understandable to least sophisticated respondent,
- avoidance of technical jargon and slang,
- respondents sometimes misinterpret very simple terms therefore we define terms very carefully,
- avoidance of controversial, racial, ethnic, or otherwise biased language,
- avoidance of double negative questions because these types of questions confuse the respondent,

3.2.4 Scale Development

Psychological scaling methods are procedures for constructing scales. For the measurements of psychological attributes many methods have been developed, with contributions coming from a variety of different fields.

Measurement of attitudes is not an easy task and if done improperly can lead to misleading results. Many researchers could not establish relationship between attitudes and other behavioral variables because of the improperly developed scales. Attitudinal scale construction efforts will follow the methods suggested by Ergun (1979).

The steps involved in scale construction are outlined below.

1. Setting the purpose of measurement for developing the attitudinal scales.
2. Definition of the environment to which the hypothetical concepts have to be related.
3. Specifying the hypothetical concepts through literature surveys focus group meetings, expert opinion and common sense.
4. Writing attributes or items related in measuring respondent's attitudes.
5. Removal of any ambiguities in the item list through expert's consent.
6. Conducting a pilot study with a convenient sample through a pretest questionnaire that contains the items that measure respondent's attitudes towards the hypothesized concepts.
7. Subjecting the responses obtained from the pilot survey to factor analysis to confirm that the listed items represent the hypothetical concepts.
8. Refinement and selection of the best attributes describing each perceptual concept that were include in the development of the main survey.

One of the task in scale development is to develop hypothetical concepts. Once these concepts are hypothesized, individual statements (items) are written related to each of these. These hypothesized concepts and individual items are given in Table 3.5. Note that all of these statements relate to the local conditions and this is clearly explained to the respondent.

Table 3.5: List of attitudinal statements selected for pilot survey.

Hypothetical concept	Statements related to hypothetical concept.
1. Regional Safety:	1. There are too many unnecessary rules on the road.
	2. I feel a bit anxious when I approach an intersection.
	3. Roads needs better maintenance.
	4. Traffic signs and signals are well placed.
	5. Drivers in Saudi Arabia obeys traffic rules in general.
	6. Traffic signs and signals are well organized and maintained in this region.
2. Degree of road safety practice	7. One should always obey traffic laws.
	8. One should avoid taking risks on the roads.
	9. It is useless to check breaks, tires and break lights on regular basis.
	10. Overtaking makes me nervous.
	11. One should always be alert of other drivers mistakes.
3. Aggressiveness in driving	12. It is sometimes a challenge to overtake the car in front of you.
	13. I wouldn't mind breaking a traffic law if it means getting out of a difficult situation.
	14. I would rather accelerate than brake to get out of a difficult situation.
	15. I like driving fast.
	16. There is never any point in taking a chance.
	17. I like competing with other vehicles on the road
4. Law Enforcement	18. Traffic policemen are helpful.
	19. Current driving licensing method is good.
	20. There should be more traffic control.
	21. There are too many unnecessary traffic signs and signals.
	22. Persons below 18 years of age should not be allowed to drive.
	23. Speeders should be penalized.

Hypothetical concept	Statements related to hypothetical concept.
5. Vehicle Environment	24. Vehicle should be checked by government agency.
	25. Lots of accidents are caused mainly because of poorly maintained vehicles.
	26. In general, vehicles are well maintained in this area.

3.2.5 Development of Initial Form

By considering all of the above mention points, the initial interview form was developed, which is given in Appendix B1 and consisted of the following parts.

Cover Letter

A cover letter, signed by the Chairman of Civil Engineering Department, was prepared. In this letter, the purpose of the interview was explained, confidentiality was stressed, time that will take to fill the questionnaire was stated and in the last thanks statement was printed.

Part A

This part included some light questions and works as a 'warm-up' for the remainder of the form. Also some essential questions related to the driving experience, such as number of accidents, motoring offenses, knowledge about some driving rules were included in this part. These questions were revised accordingly to the responses and comments that were obtained from the respondents in the final questionnaire.

Part B

To study the attitudes of driver various statements were prepared. The attitudinal statements related to some hypothetical concepts were gathered through literature review, 'focus group' meetings with advisors, with some drivers and by discussions among the research team. The final list which was included in the pilot survey questionnaire is presented in Table 3.5. This list contained 26 attitudinal statements. The drivers were asked to respond to these statements using a five point

Likert scale. These statements were randomly ordered and included in the pilot questionnaire which is given in the Appendix B1.

Part E

Part E of the questionnaire contain the questions related to socio-economical background of the respondent. In this part questions related to age, income, nationality, occupation, marital status, number of children and state of health were asked.

3.2.6 Pilot Survey for Violator Study

To test the draft form, a pilot study was performed. The objectives of the pilot study were as follows:

1. To see if the respondents have any difficulty in understanding and responding to any question.

2. To test and revise the attitudinal questions related to driving attitudes. This was, probably, the most important reason for running the pilot test.

Originally this part contained 26 questions and it was necessary to shorten this list in a meaningful way to reduce the response time and yet be able to have reliable attitudinal scale.

Pilot testing was achieved by a convenient sample among the university students, faculty, staff, friends and relatives outside the campus. Fifty six interviews were obtained by a close follow up. These questions were delivered and picked up from the respondents. This sample size was deemed sufficient for the pilot study purposes.

Various comments were made about some of the question (the respondents were asked if they had any comments and difficulty about the form when it was picked up). All these comments were taken care in the final form.

3.2.7 Factor Analysis of the Attitudes

The 26 statements related to driving attitudes were subjected to factor analysis in order to validate the hypothesized concepts and to reduce the number of items as describe below. Based on the correlation among the 26 items, factor analysis groups these items into 'factors'.

In this study factor analysis was mostly used in a 'confirmatory' manner because factors were already hypothesized as given in Table 3.5. However it will also be used in reducing the number of items as indicated below.

Factor analysis was performed using principal component technique and varimax rotation with SAS package. Rotated orthogonal factor loadings were obtained for solutions in 4 through 9 factors. The rotated factor patterns for these solutions are given in Appendix C. The results of these solutions are summarized in Figure 3.3. In this figure, the attributes that have high loadings on each factor solution are indicated and the factors have been named after the items that have high loading on them.

One criterion for deciding about the number of factors is the eigenvalue criterion which suggests that factor extraction should be stopped when the eigenvalues drop below 1. The eigenvalue plot for different number of factors is given in Figure 3.4. According to this figure, eigenvalues fall below 1.0 at nine factors,

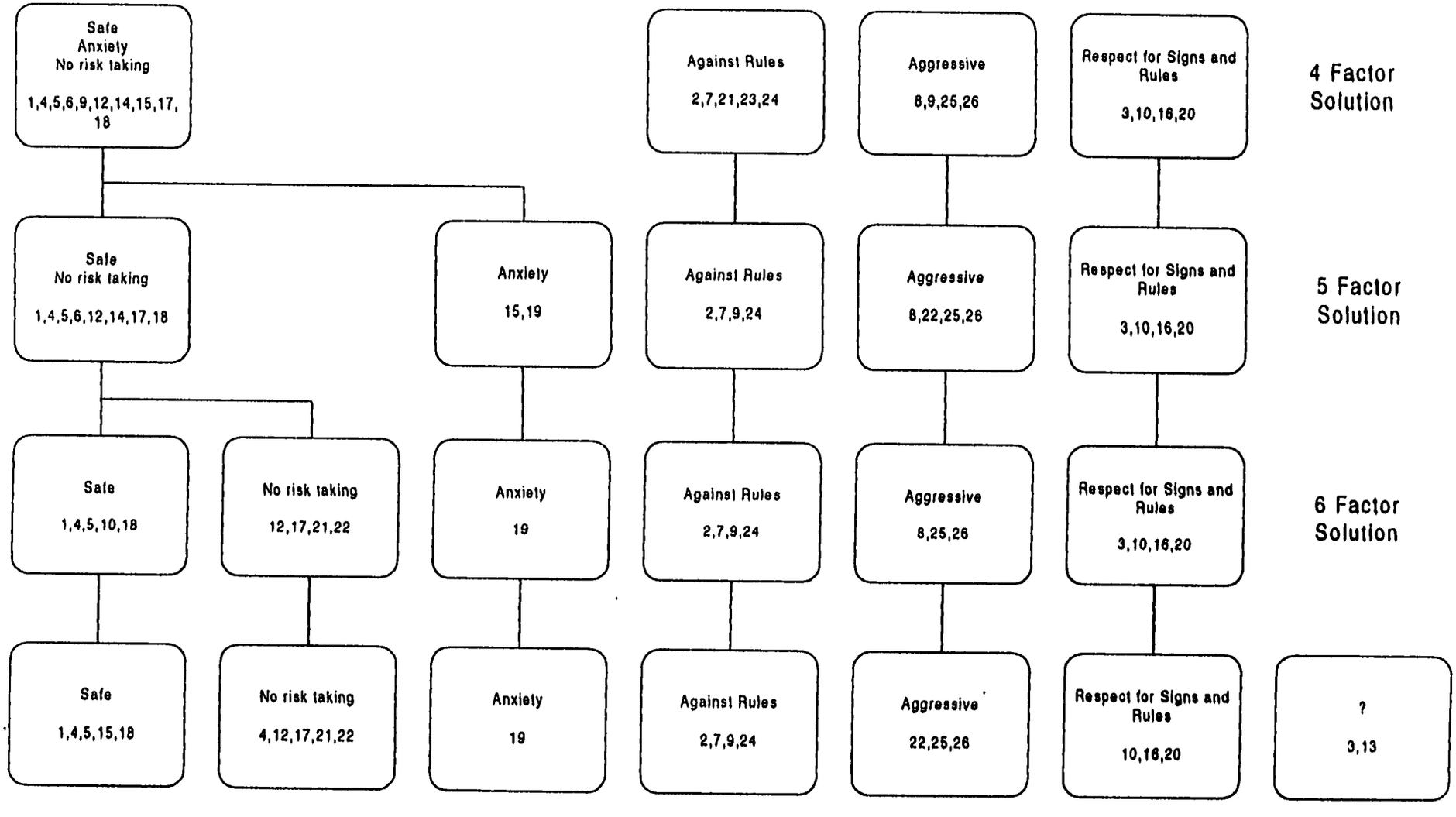

Figure 3.3: Summary of factor analysis for pilot study

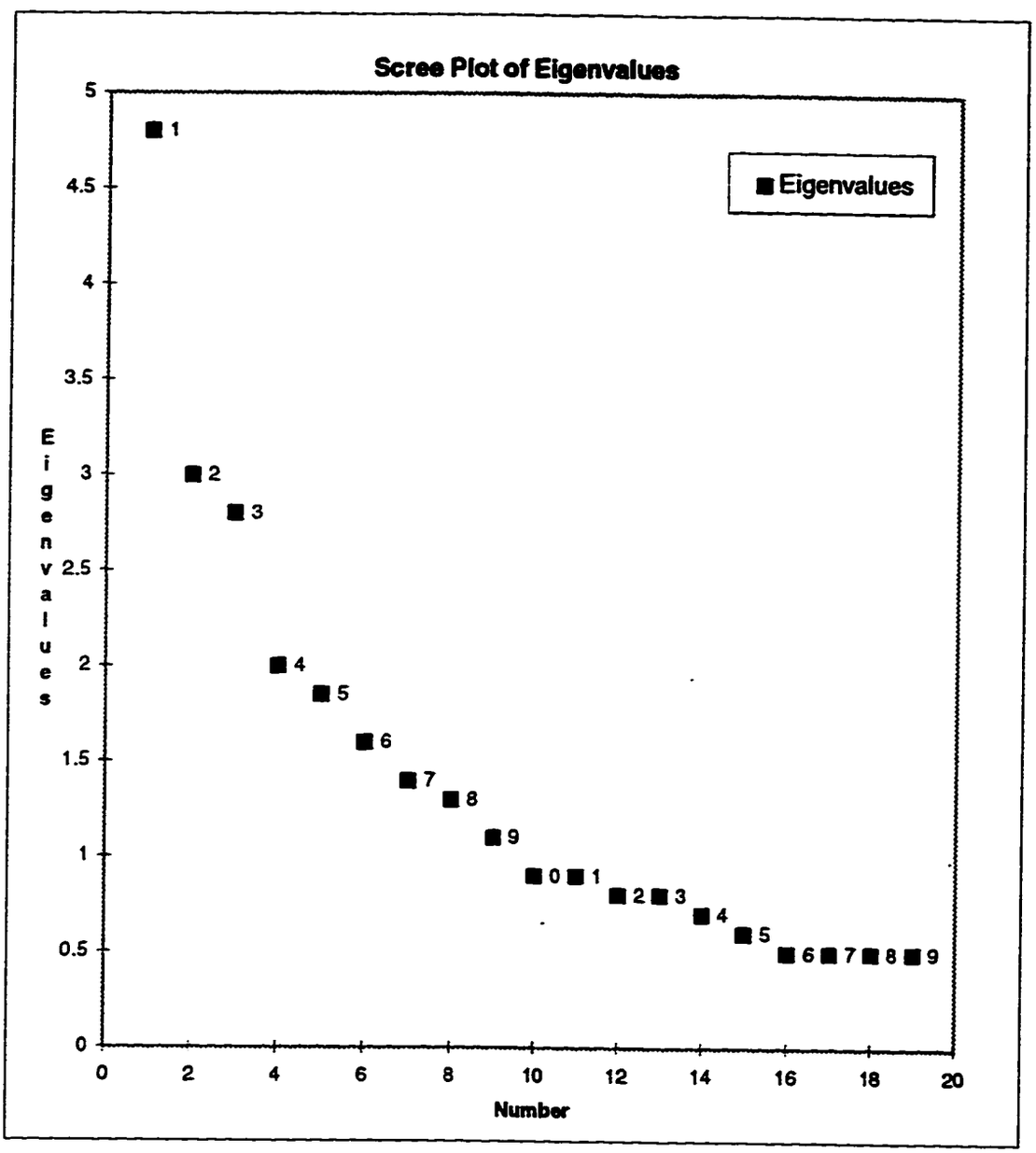

Figure 3.4: Eigenvalue plot of factor analysis for pilot study

therefore we can extract up to nine factors. However, many of the factors become meaningless as explained below after five factors.

Another criterion is the 'interpretability' of the factors. From the loaded items in the factor (see the factor loading in rotated factors in appendix), they should represent a clear meaning. As can be seen from Figure 3.3, some of the factors become meaningless after the five factor solution or had factors with very few statements.

Also in the five factor solution, the road anxiety factor had only two items which were seemingly unrelated. Later on, one of these statements disappeared from this factor. Therefore, this factor does not seem to be a stable one. On the other hand, in the six-factor solution 'Non-Risk Factor' emerged and remained as a stable solution for the remainder of analysis.

The 'Sign and Rule Consciousness' factor had the following stable statements.

Item 10: Traffic signs and signals are well organized and maintained in this region.

Item 16: There are too many unnecessary rules on the roads.

Item 20: Traffic signs and signals are well placed.

Although item 3 had some low loadings at the beginning, it disappeared from this factor in higher factor solutions. Item 10 and item 20 are almost similar in meaning therefore it was decided to drop this factor from the main survey. Finally, fifteen items 3 or 4 items each factor that had the highest loading in each factor were selected to be included in the main survey and these are given in Table 3.6. As can be seen from this table there is considerable agreement with the original concepts stated in Table 3.5

Table 3.6 Final attitudinal statements

Hypothetical Concept	Attitudinal Statement
Safe Driving Attitude	One should always obey traffic laws.
	I would rather accelerate than brake to get out of a difficult situation.
	I feel a bit anxious when I approach an intersection.
	I don't feel safe when I drive on roads.
Non-Risk Taking Attitudes	One should avoid taking risks on the roads.
	I like competing with other vehicles on roads.
	I like driving fast.
	Drivers in Saudi Arabia obey traffic rules in general.
Anti-Regulatory Attitude	There are too many unnecessary traffic signs and signals.
	It is useless to check brakes, tires and brake lights on a regular basis.
	There should be more traffic enforcement.
	I wouldn't mind breaking a traffic law if it means getting out of a difficult situation.
Aggressive Driving Attitude	In general, vehicles are well maintained in this area.
	It is sometimes a challenge to overtake the car in front of you.
	There is never any point in taking a chance.

3.2.8 The Final Form

The final form was obtained from the initial form which was revised through the pilot test and it is given in Appendix B2. The main difference between the final form and the initial form is in the attitudinal questions. This part included only the fifteen items selected in the section above. There were also few modifications in other parts of the questionnaire which resulted from the suggestions of the respondents and further analysis of the initial questionnaire.

3.2.9 Number of Interviews

The main purpose of interviews was to determine the characteristics of the violators. Therefore the following formula was used for this purpose.

$$N = \frac{pq\,K^2}{E^2}$$

where

N = minimum sample size

p = proportion of drivers or pedestrian having a certain characteristics (for instance low income)

q = proportion of drivers or pedestrians that do not have the desired characteristics (1 - p)

K = constant corresponding to desired confidence level

E = permitted error in the proportion estimate of observance

Assuming p = 0.25, q = 0.75 and selecting a level K = 1.96 for 95% confidence and using $E = +0.10$

$$N = \frac{(0.25)(0.75)(1.96)^2}{(0.10)^2}$$

$$N = 72$$

Hence a sample size of 75 were used for interviews of each category. This study was part of another more comprehensive study (Al-Senan et al.,1997) which studied two main categories of violators i.e. red light violator, speed violator and a control group. Therefore, a total of (72*3) 216 interviews required.

3.2.10 Interviewing

The questionnaire was translated into Arabic. The interviews were conducted in the afternoons for two successive weeks. The interviewing was carried out by 5 of part time interviewers recruited from research assistants and undergraduate students studying at KFUPM. Each interviewer attended a one hour verbal briefing and received written instructions on the administration of the questionnaire. They were given lectures describing the purpose of this study and explaining the questionnaire in order to make them familiar with the subject. The components of the questionnaire were described in great detail and any question about the subject was clarified.

To avoid biased result the interviewers were asked to behave very politely and try to persuade the respondents that their contribution was essential for this study.

Furthermore, the local police helped a lot in this regard by not charging fine for the violation. When the violator were told that, no fine for violation will be charged he respond in a good manner. Out of 240 interviews, 79 interviews were collected from signal violators, 63 interviews were collected from speed violators and remaining 80 interviews were collected from control group to compare the characteristics of violator and non violator. Later on, during data feeding few interview forms were found incomplete or missing some of information. These interview forms were rejected. Finally, the data of 222 interview forms were put into computer after coding. The coding manual of interview forms is given in Appendix E2.

3.3 Data Analysis

To quantify driver noncompliance with traffic signals, the number of violations and violations rates for each violation will be examined to assess the overall noncompliance problem. Intersection characteristics such as the number of approach lanes, land use, cycle lengths, and traffic volume levels will be examined in conjunction with violation occurrence. The drivers' characteristics will also be examined in conjunction with violation occurrence. Summary statistics for noncompliance study will be expressed as proportion or percentage values. T test will be performed to check the difference in means in continuous variable. Analysis of correlation will be performed to establish the relationship between noncompliance and driver behavior. Following is the short explanation of the statistical techniques used in the study.

3.3.1 Multiple Regression

Multiple regression is a general statistical technique through which one can analyze the relationship between a dependent or criterion variable and a set of independent or predictor variables Montgomery, (1990). In general, multiple regression requires that variables are linear and additive. These restrictions are not absolute, however, nominal variables can be incorporated into regression through the use of "Dummy".variables.

$$\hat{Y} = A + B_1X_1 + B_2X_2 + B_3X_3 + \text{----------} B_kX_k \quad \text{_____(1)}$$

Where $\hat{Y}$ represents the estimated value for Y, A is the Y-intercept and B_i's are regression coefficients. The A and B_i coefficients are selected in such a way that sum of squared residuals $\Sigma (Y - \hat{Y})^2$ is minimized.

The selection of optimum A and B_i coefficients using the least-squares criterion implies that the correlation between the actual Y values and the $\hat{Y}$ estimated values is maximized, while the correlation between the independent and the residuals values $(Y - \hat{Y})$ is reduced to zero. The actual calculation of A and B_i, requires a set of simultaneous equations derived by differentiating $\Sigma (Y - \hat{Y})^2$ and equating the partial derivatives to zero. Regression coefficients Bi are tested statistically using F test and T test.

It is also of interest to examine the contribution of added variables to the explanation of dependent variable Y. And this could be easily stet. using stepwise

regression. For example, if it is desired to test the hypothesis that X3 and X4 do not add significantly to the explanation of Y (dependent variable) over and above X1 and X2, the following F-test can be used:

$$F = \frac{\text{(Incremental SS due to X3 and X4)} / M}{SS\mathit{residual} / (N - K - 1)}$$

Where,

SS = The explained sum of squares,

$SS_{residual}$ = the unexplained error sum of squares,

M = the number of variables in the subset (X3, X4),

N = the number of observations and,

K = the total number of variables.

To test the null hypothesis H_o : B3=B4=0 (i.e. X3 and X4 add no explanation to Y). F statistic (at the desired level of significance) can be used. If the calculated F is greater than the table F, the null hypothesis will be rejected, which means that X3 and X4 add no significant explanation to Y.

3.3.2 Analysis of Variance (ANOVA) and Covariance (ANCOVA)

Simple analysis of variance and covariance must have a criterion or dependent variable, measured on interval scale. In the analysis of variance, non-metric independent variables are called 'Factors'. The possible effects of a single factor, is termed as a one-way analysis of variance. The simultaneous effects of n factors, is termed as an n-way analysis of variance. If one is interested in analyzing the effects of both non-metric and metric independent variables, the analysis is referred to as an

analysis of covariance. In this latter analysis, the metric independent variable is referred to as a covariance. The statistical test of the null hypothesis is done using an F test.

The basis of analysis of variance is the decomposition of variation or sums of square corrected for the mean (SS). Consider a one-way analysis of variance with a dependent or criterion variable Y and a categorical independent variable or factor, A. The total sum of squares in Y, SS_y , can be decomposed into two independent components:

$$SS_y = SS_{between} + SS_{within}$$

$SS_{between}$ is the portion of the sum of squares in Y due to Factor A, that is due to the variation in the Y_j which is the means of the categories of the Factor A. Thus $SS_{between}$ is denoted as SS_A . The SS_{within} is the portion of the sum of squares in Y due to the variation within each of the categories of A. The SS_{within} is variation which is not accounted for by factor A, and is denoted as SS_{error}. Thus,

$$SS_y = SS_A + SS_{error}$$

The relative magnitude of SS_A will become greater as the differences among the means of Y in various categories of A (Y_j) increase and as the variation in Y within the categories of A decrease.

If there are two factors, ANOVA can test:

1. whether the two factors as a whole have a statistically significant effect,
2. whether the interaction effect is significant,
3. the significance of each factor (main effects),

3.3.3 Factor Analysis

Factor analysis technique is used to develop attitudinal scales, which are weighted sums of the responses to single attitudes (Nie, et. Al, 1975). In effect, factor analysis is used to reduce the dimensionality of the attitudes combining them in common cognitive dimensions. This is also needed because it is known in psychometrics that single attitudes have low reliability.

Factor analysis technique assumes that the individual's ratings of attributes include a common component which represents the cognitive dimensions, an attribute specific component, and some measurement error (Koppelman and Hauser, 1977)The basic model may be expressed as follows:

$$Z_j = \alpha_{j1} F_1 + \alpha_{j2} F_2 + \text{----} + \alpha_{jm} F_m + d_j U_j \qquad j=1,2,\text{---},n$$

where

Z_j = variable j in standardized form,

Fi = hypothetical factors,

α_{ji} = standardized multiple regression coefficient of variable j on factor i (factor loading),

U_j = unique factor for variable j,

dj = standardized regression coefficient of variable j on unique factor j,

For this study common factor analysis without iterations and varimax rotation was used.

Chapter No 4

Analysis of Traffic Violations

4.1 General

The traffic violation study was analyzed statistically by using correlation, Anova, Ancova, and regression. Also comparison of the traffic violations with other studies have been made.

4.2 Coding and Checking the Data

All the data were coded and checked for coding errors by getting various statistics as shown in Table 4.1. This analysis involved determining the total count, mean, standard deviation and the minimum and maximum values. The absence of the out of range values indicated absence of coding errors. The codes and the explanation of the variables used in the analysis are given in Appendix E1.

Table 4.1: Means, minimum, maximum values and standard deviation for all variables.

Variable	N	Minimum	Maximum	Mean	Std Dev
APPROACH	144	1.00	4.00	2.50	1.12
TIME	144	1.00	3.00	2.00	0.82
AREA	144	1.00	2.00	1.50	0.50
LOCATION	144	1.00	5.00	3.25	1.24
LAND_USE	144	1.00	2.00	1.67	0.47
AP_WIDTH	144	5.90	25.15	12.76	4.00
MD_WIDTH	144	0.00	18.50	3.19	4.66
MD_EXIST	144	0.00	1.00	0.88	0.33
EXLFT_LN	144	0.00	2.00	0.67	0.52
EXRDT_LN	144	0.00	1.00	0.65	0.48
LN_MARK	144	0.00	1.00	0.60	0.49
NOOF_LN	144	1.00	7.00	3.67	1.13
THRU_LN	144	1.00	5.00	2.33	0.79
PED_CRSS	144	0.00	1.00	0.67	0.47
STR_TYPE	144	1.00	3.00	2.04	0.79
SIGHT	144	1.00	2.00	1.17	0.37
PED_ACT	144	1.00	2.00	1.25	0.43
YTIMR	144	3.00	3.00	3.00	0.00
RTIME	144	65.00	113.00	88.17	13.80
GTIME	144	11.00	50.00	25.34	9.94
CYCTIME	144	88.00	130.00	116.53	15.7[illegible]
VOL_LFT	144	7.00	586.00	94.52	101.84
VOL_ST	144	0.00	705.00	214.97	179.93
VOL_RGT	144	0.00	1115.00	59.53	96.73
VOL_TOT	144	54.00	1375.00	369.02	268.62
HVOL_LFT	144	14.00	1172.00	189.04	203.67
HVOL_ST	144	0.00	1410.00	429.93	359.87
HVOL_RGT	144	0.00	2230.00	119.07	193.47
HVOL_TOT	144	108.00	2750.00	738.04	537.24
FREECH	144	6.00	104.00	47.94	18.69
NSY	144	0.00	74.00	11.83	11.97
NSR	144	0.00	24.00	5.29	6.16
NSR5SEC	144	0.00	11.00	0.65	1.30
SOR	144	0.00	33.00	11.81	7.63
RORWS	144	0.00	62.00	12.16	12.24
RORWOS	144	0.00	95.00	17.30	14.99
HFREECH	144	12.00	208.00	95.85	36.25
HNSY	144	0.00	148.00	23.65	23.93
HNSR	144	0.00	48.00	10.58	12.31
HNSR5SEC	144	0.00	22.00	1.31	2.61
HSOR	144	0.00	66.00	23.63	15.26
HRORWS	144	0.00	124.00	24.32	24.49
HRORWOS	144	0.00	190.00	34.60	29.97
MEAN	144	0.00	88.70	49.29	18.08
STDD_DEV	144	0.00	52.93	10.56	5.84
V15THPER	144	0.00	74.70	39.00	15.03
V85THPER	144	0.00	106.00	58.97	21.49
TOTVIOL	144	10.00	388.00	118.08	66.11
HVOLTHRU	144	26.00	2318.00	618.97	477.17

The various violation categories were converted into rates to allow comparison. The conversion into rates was done by dividing each category by its respective volumes. This was done as follows:

hnsy1 = hnsy*100/hvolthru

hnsr1 = hnsr*100/hvolthru

hnsr51 = hnsr5*100/hvolthru

hsor1 = hsor*100/hvolthru

hrorws1= hrorws*100/hvol_rgt

hrorwos1= hrorwos*100/hvol_rgt

ror1 = ror*100/hvol_rgt

totviol1= totviol*100/hvol_tot

To clarify the results, these comparisons were plotted as bar charts as shown in Figure 4.1 and Figure 4.2. As can be seen from Figure 4.1, a total of 118 vehicles violated the red and yellow signals during an average hour per approach. This frequency is very high. The breakdown of total violation in terms of specific violation is as follows:

On the average, 23.65 drivers cross the intersection at yellow, 10.58 cross on red, 23.63 start on red, 24.32 turn light on red with stopping a 34.6 turn right on red without stopping per hour per approach. The most dangerous violation of all is not stopping on red after the red light is on for 5 seconds (HNSR5SEC) and the frequency for this violation was 1.31.

Figure 4.2 shows the violation rate by violation type. This Figure shows that the highest violation rate is for right turn on red (ROR) which is a combination of

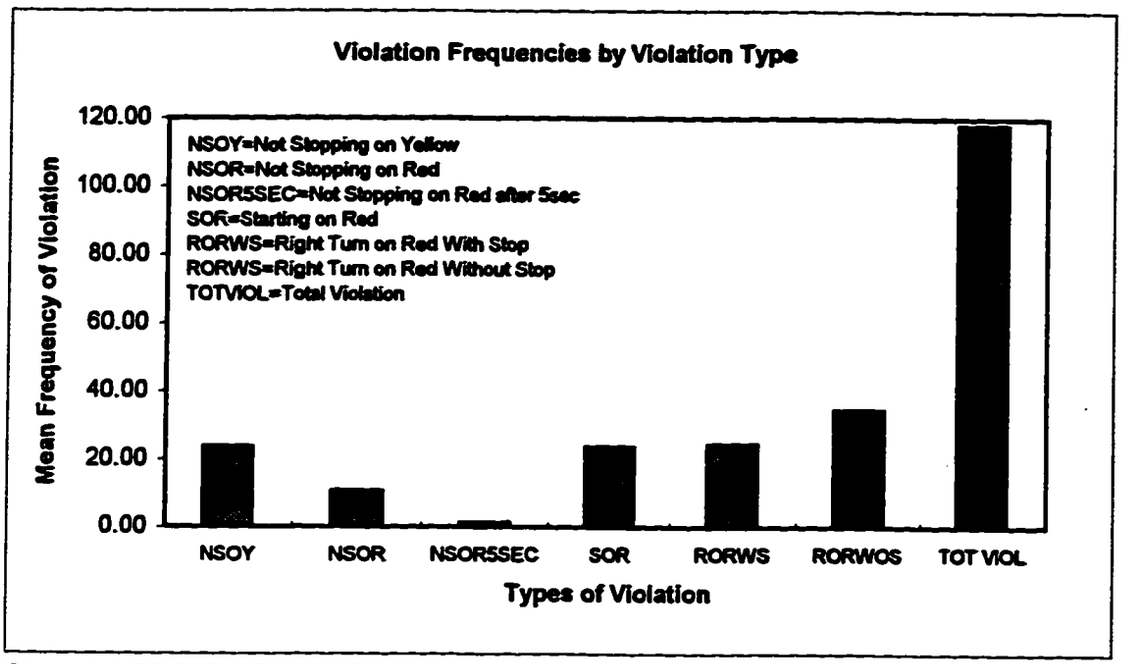

Figure 4.1: Violation frequencies by violation type

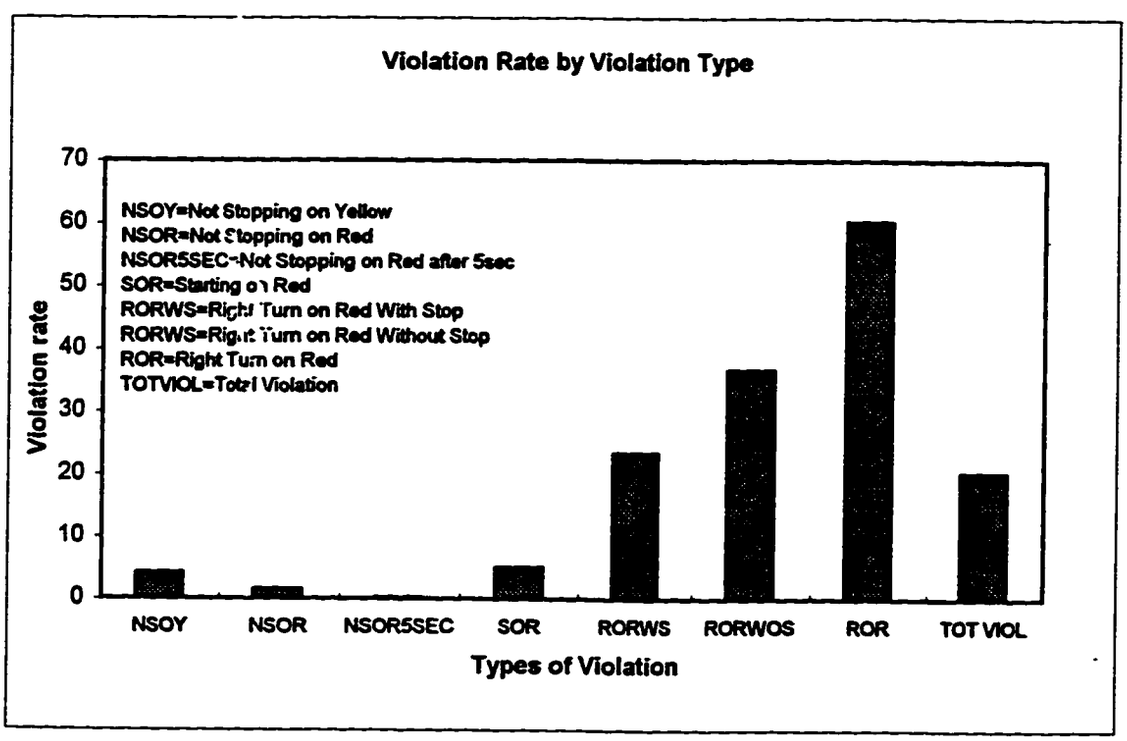

Figure 4.2: Violation rates by violation type

right turn on red with stop (HRORWS), right turn on red without stop (HRORWOS). Starting on red (HSOR) has highest violation rate among through volume violations followed by not stopping on yellow (HNSY), not stopping on red (HNSR). The not stop on red after red light is on for 5 seconds (HNSR5SEC) has the lowest violation rate as compared to other violation rates, but this violation is the most dangerous of all violations.

4.3 Analysis of Data

4.3.1 Correlation Analysis of Data

To find out the potential relationship between the volume signal and speed variables and the violation variables, Person's Correlation Analyses were performed using SAS (1990). The detailed results of these correlation analyses are given in Appendix D. The results of correlation analysis are summarized in Table 4.2. In Table 4.2, only those variables which were found significantly correlated with violation variable at 5% significance level are given.

Not stopping on yellow (HNSY) and not stopping on red (HNSR) are affected by exactly the same variables. Among volume variables, HNSY and HNSR are affected by hourly volume left (HVOL-LFT), hourly volume straight (HVOL-ST), hourly volume total (HVOL-TOT) and hourly free choice (HFREECH). These two violation variables do not have any correlation with hourly volume right (HVOL-RGT). Among signal timing variables, these two variables, i.e. HNSY and HNSR

Table 4.2: List of variables with significant (at least 5%) correlation with violations.

Variables	Pearson correlation coefficient for violations							
	HNSY	**HNSR**	**HNSR5 SEC**	**HSOR**	**HRORWS**	**HRORWOS**	**ROR**	**TOT VIOL**
AP_WIDTH	-	-	0.28	0.18	-	-	-	-
Volume Variables								
HVOL_LFT	0.35	0.39	0.20	0.39	-	-	-	0.38
HVOL_ST	0.53	0.63	0.32	0.42	-	-	-	0.46
HVOL_RGT	-	-	-	0.24	0.37	0.42	0.50	0.46
HVOL_TOT	0.53	0.59	0.30	0.52	-	0.29	0.27	0.61
HFREECH	0.40	0.42	0.20	0.66	-	0.24	-	0.46
Signal timing variables								
RTIME	-	-	-	0.18	-	-	-	0.21
GTIME	0.37	0.48	0.26	0.42	-		-	0.34
CYCTIME	0.37	0.43	0.25	0.43	-		-	0.40
Approach Speed Variable								
MEAN	0.22	0.20	-	0.20	-	-	-	0.18
STDD_DEV	0.20	0.21	-	-	-	-	-	-
V15THPER	0.18	0.16	-	0.18	-	-	-	-
V85THPER	0.24	0.22	-	0.18	-	-	-	0.20

violations are affected by all variables, i.e. (green time (GTIME), cycle time (CYCTIME), except red time (RTIME).

When we consider speed variables, HNSY and HNSR have significant positive correlations with all speed variables i.e. (MEAN, STDD-DEV, V15THPER, V85THPER). HNSR5SEC violation is also affected by the same volume and signal variables as those of HNSR and HNSY. However, HNSR5SEC is not affected by any of the speed variables, but it is affected by MD-WIDTH variable.

Starting on red (HSOR) violation is affected by all volume, signal and speed variables except standard deviation (STDD-DEV). HSOR has also weak correlation with median width (MD-WIDTH). HRORWS is only affected by hourly volume (HVOL-RGT). This is logical because only right turning vehicles can make this violation. Similarly, HRORWS and ROR have significant positive correlation with HVOL-RGT and HVOL-TOT. As HVOL-TOT is the sum of HVOL-LFT, HVOL-RGT, HVOL-ST, so it should be noted that HRORWOS and ROR have strong positive correlation with HVOL-RGT but they have weak correlation with HVOL-TOT. HRORWOS is also affected by free choice (HFREECH) variable. Total violation has positive significant correlation with all three classes. It is affected by all volume variables, all signal timing variables and all speed variables except STDD-DEV and V85THPER.

4.3.2 Analysis of Covariance (ANCOVA) Of Categorical Variables

ANCOVA was performed to find out the effects of categorical variables on violation frequencies. In ANCOVA, one way analysis of variance (ANOVA) is performed with significant covariates. Significant covariates were obtained by using stepwise regression analysis. These significant covariates are given at the footnote of Table 4.3. The variables that had a significant effect on violations are summarized in Table 4.3.

As can be seen from Table 4.3, time, area, land-use and street type (STR-TYP) had no significant affects on any of the violation. Whereas location, lane marking (LN-MARK) and pedestrian crossing (PED-CRSS) affect only one violation each. Location and pedestrian crossing affect starting on red (HSOR) while lane marking affects HRORWS.

Among geometric variables, i.e. existence of median (MD-EXIST)), existence of left turn lane (EXLFT-LN), existence of right turn lane (EXRDT-LN), and sight distance (SIGHT), the EXLFT-LN and EXRDT-LN seems important. EXLFT-LN affects HNSR, HSOR and HRORWOS while EXRDT-LN affects mainly right turn on red violations i.e. HRORWS and HRORWOS but it also has an affect on starting on red (HSOR) violation, the reasons of which are not very obvious. Existence of median (MD-EXIST) affect HSOR, HRORWOS and ROR violations, where ROR is a sum of HRORWS and HRORWOS violations, while the sight distance (SIGHT) affects right turn on red with stop (HRORWS) and right turn on red (ROR) violations.

Table 4.3: Results of One-way ANOVA's with covariates[1]

Variable	F-Statistic value for the significant[2] effects on violation							
	HNSY	HNSR	HNSR5 SEC	HSOR	HRORWS	HRORWOS	ROR	TOTVIOL
TIME	–	–	–	–	–	–	–	–
AREA	–	–	–	–	–	–	–	–
LOCATION	–	–	–	4.27	–	–	–	–
LAND_USE	–	–	–	–	–	–	–	–
MD_EXIST	–	–	–	6.18	–	29.03	9.14	–
EXLFT_LN	–	3.94	–	13.83	–	28.54	–	–
EXRDT_LN	–	–	–	11.34	3.98	3.24	–	–
LN_MARK	–	–	–		4.54	–	–	–
NOOF_LN	2.28	2.58	–	3.17	–	3.11	–	–
THRU_LN	–	–	–	4.36	4.47	–	–	–
PED_CRSS	–	–	–	7.10	–	–	–	–
STR_TYP	–	–	–	–	–	–	–	–
SIGHT	–	–	–	–	13.96	–	3.95	–

[1] Covariates used for various violations are:

for HNSY: MD_WIDTH, HVOLTHRU, GTIME

HNSR: MD_WIDTH, HVOLTHRU, GTIME

HNSR5SEC: MD_WIDTH, HVOLTHRU,

HSOR: HVOL_TOT

HRORWS: HVOL_RGT

HRORWOS: MD_WIDTH, HFREECH, HVOL_RGT

ROR: HVOL_RGT

TOTVIOL: HVOL_TOT, MD_WIDTH, GTIME

[2] Significance level at least 5%

4.3.3 Least Square Means (LS-MEANS) of Significant Categorical Variables

To get the clear picture of relationship between categorical variables and violation frequencies, least square means (LS-MEANS) of these categorical variables were obtained using SAS package. Least square means are the means which were obtained after adjusting the effects of covariates. These Least Square Means are summarized in Table 4.4.

As can be seen from Table 4.4, that existence of median reduces the right turn on red without stop (HRORWOS) and total right turn on red (ROR) violations. This is probably because median exists on large intersections and on large intersections people are more cautious. Existence of left turn lane (EXLFT-LN) reduces almost all violation frequencies except it does not have any effect on HRORWS and it increases HSOR. Since HSOR is not a dangerous violation as compared to other violation types, it can be concluded that the existence of left turn lane increases the compliance at signalized intersections.

Existence of right turn lane reduces the starting on red (HSOR) and right turn on red with stop violation (HRORWS). However, it increases the right turn on red without stop violation. This is, probably because the existence of right turn lane makes right turning easy. Therefore, the overall safety benefit of existence of right turn lane is questionable.

Number of lanes do not give consistent results. However, when there is only one lane on an approach, the violation frequency is higher for HNSY, HNSR and

Table 4.4: Adjusted means for the categories of variables that has a significant effect on violations.

Variable Categories	Adjusted means for violation					
	HNSY	HNSR	HSOR	HRORWS	HRORWOS	ROR
MEAN						
NOT EXIST	–	–	–	–	67.77	83.44
EXIST	–	–	–	–	28.86	55.41
LEFT TURN LANE						
NOT EXIST	24.53	12..91	17.83	–	53.26	83.44
EXIST	23.17	9.30	26.80	–	24.36	55.41
RIGHT TURN LANE						
NOT EXIST	–	–	28.68	29.41	29.06	–
EXIST	–	–	20.86	21.53	37.63	–
LANE MARKING						
NOT EXIST	–	–	–	29.30	–	–
EXIST	–	–	–	21.06	–	–
NO OF LANES						
1	23.06	17.71	21.69	–	46.35	–
2	17.41	11.51	12.34	–	53.81	–
3	22.10	11.54	22.27	–	40.48	–
4	30.86	12.99	26.95	–	18.72	–
5	22.82	6.63	23.77	–	35.58	–
7	-2.74	-5.9	34.64	–	22.17	–
THRU LANES						
1	–	–	13.47	39.05	–	–
2	–	–	22.53	23.84	–	–
3	–	–	27.50	19.20	–	–
5	–	–	35.07	43.67	–	–
PED. CROSSING						
NOT EXIST	–	–	27.93	–	–	–
EXIST	–	–	21.47	–	–	–
SIGHT DISTANCE						
NOT EXIST	–	–	–	21.27	–	56.14
EXIST	–	–	–	39.57	–	72.79

HSOR as compared to two lanes or three lanes on approach. This might be because one lane approaches are usually at fringe areas, and on fringe areas traffic volume is very low and enforcement is also very little. As number of thru lane increases, starting on red (HSOR) violation also increases. This is because at major intersections, the number of thru lanes are greater; also volume is more which result in longer signal cycle length and ultimately increases the delay. These delays makes the impatient driver to start on red. At major intersections, we can increase the compliance of red signal by reducing these delays through adjustment of signal cycle length.

Both existence of lane marking (LN_MARK) and good sight distance (SIGHT) reduce the right turn on red without stop violation. Good sight distance also decreases the total right turn (ROR) on red violation. It is concluded that the presence of lane marking and sight distance improvement increase the compliance at signalized intersection. Hence, lane marking and improvement of sight distance are beneficial.

Existence of Pedestrian crossing (PED-CROSS) reduces the starting on red violation. This is very logical result because when pedestrian crossing exists, drivers stop their vehicles far behind the stop line due to the width of the pedestrian crossing. Drivers also do not want have conflicts with the pedestrians. As existence of pedestrian crossing decreases the starting on red violation at intersections, it is concluded that the presence of pedestrian crossing is beneficial at intersections from compliance point of view.

4.4 Comparison with Riyadh and USA Studies

The comparison this study (Eastern Province) with Riyadh study (Goushki and Ghadeer, 1993) and USA study (Gordon and Robertson, 1990) is made in this section. The Riyadh study was conducted in May 1990, while the USA study was conducted in July 1986.

In Table 4.5, comparison statistics are summarized for not stopping on red and right turn on red violation frequencies for these studies. The mean violation frequencies for these two violation types are also shown in Figure 4.3 and Figure 4.4. From Figure 4.3, it is clear that Eastern Province has the highest mean frequency of not stopping on red violation followed by Riyadh and Buraidah. The USA has the lowest mean frequency for not stopping on red. The mean frequencies value of Eastern Province and Riyadh is 8 times and 6 times of the USA mean frequency value respectively. These values are very high and indicator of the poor situation prevailing in Saudi Arabia in terms of non- compliance behavior at signalized intersections.

Figure 4.4 compares the mean violation frequencies of right turn on red for Riyadh, USA and Eastern Province. As can be seen from the Figure that Riyadh had the highest right turn on red violation frequency but it was very close to Eastern Province violation frequency. However, there is a very big difference between the USA frequency values and Saudi Arabian frequency values.

Comparison of violation rates of Eastern Province are also made with Riyadh, Buraidah and the USA and are summarized in Table 4.6. As can be seen from Table 4.6, that Eastern Province has the highest rate of not stopping on red (HNSR)

Table 4.5: Comparisons of violation frequencies

Vriable name	Violation type							
	Not Stopping on Red				Right Turn on Red			
	Riyadh*	Buraidah*	US**	Eastern Province	Riyadh*	Buraidah*	US**	Eastern Province
Range of viol. per hour	24-69	5.0-14	0-11	0-48	97-615	27-79	0-8	0-190
Mean no of viol. per hour	31.40	9.20	4.90	42.33	264.30	56.50	3.40	235.64
%age of at least one viol per hour	100.00	100.00	54.30	100.00	100.00	100.00	48.70	100.00
No of viol per app per hour	7.90	2.30	1.20	10.58	66.10	14.10	0.84	58.91

* Koushki & Ghadeer (1993)

** Gordon & Robertson (1990)

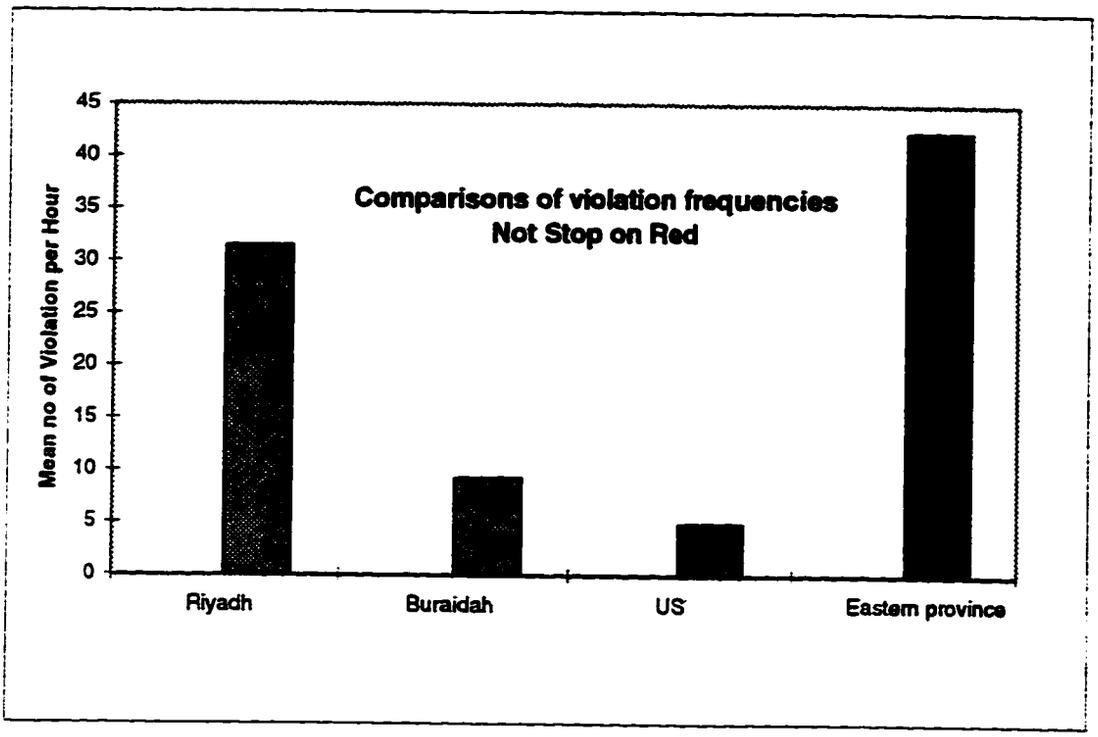

Figure 4.3: Coparison of violation frequencies for not stoping on red.

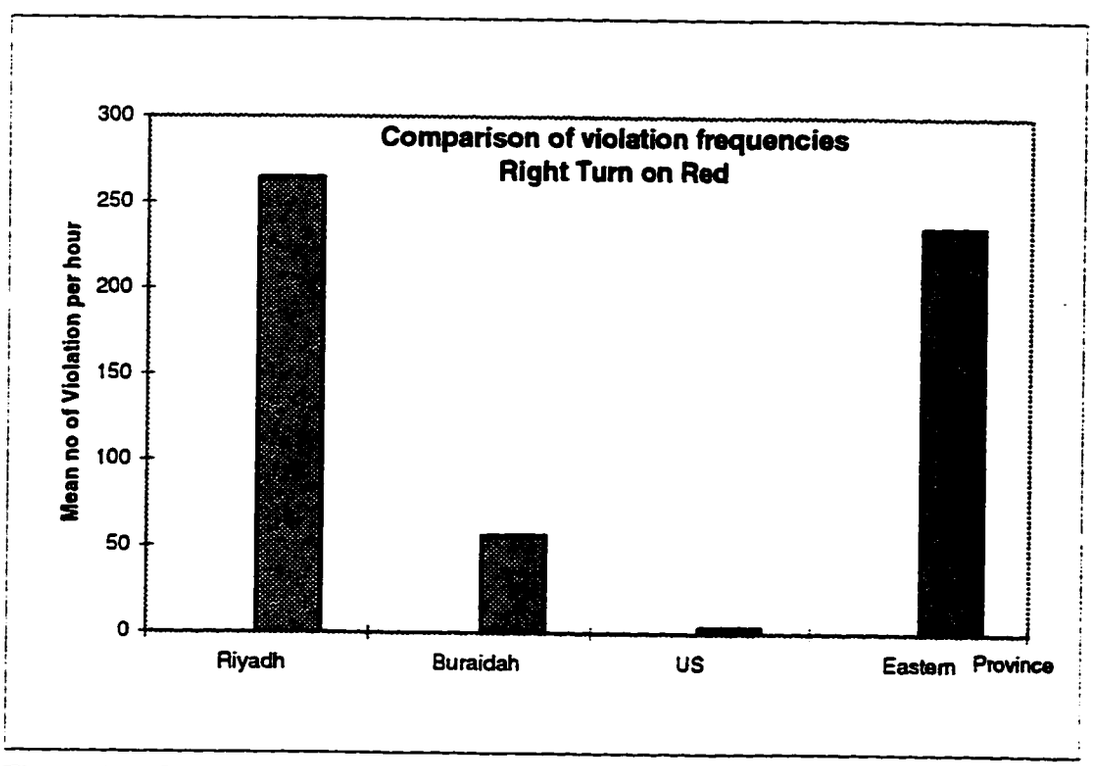

Figure 4.4: Comparison of violation frequencies for right turn on red.

violation followed by Riyadh and Buraidah and the USA. In the Eastern Province, on the average, 1.55 drivers do not stop on red out of 100 through vehicles. This value for Riyadh is 1.24 and for the USA 0.41 which is approximately 4 times less as compared to the Eastern Province average.

Table 4.6 also indicates that Right turn on red violation rate is highest in Riyadh followed by Eastern Province and Buraidah. The USA violation rate for right turn on red is very low. Another rate for this violation is obtained for Eastern Province by dividing the right turn on red violation with relevant volume of right turn only. Sixty percent of the vehicles violate red signal when they make right turn in Eastern province. If we compare the total violation rate at signalized intersection, the Eastern Province and Riyadh have approximately the same values followed by Buraidah and the USA. Therefore, it is concluded that the violation rate at signalized intersection in Saudi Arabia is 15-16 times higher than the violation rate at signalized intersections in the USA. These comparisons indicate the very high rate of non compliance at signalized intersections in Saudi Arabia.

Table 4.6: Comparison of Violation Rate

LOCATION	Overall Mean Violation Rate for Violation Types		
	Not Stopping on Red	Right Turn on Red	Total violation
Riyadh[1]	1.24	17.40	20.70
Buraidah[1]	0.93	9.50	12.50
USA[2]	0.41	2.00	1.25
Eastern Province	1.55	11.54 (60.26)[3]	20.29

[1]Koushki and Ghadeer (1993)
[2]Gordon and Robertson (1990)
[3]The rate in parenthesis is obtained by dividing the the right turn on red violations by the right turn volume only. The other figure was obtained with total volume.

Chapter 5

Analysis of Violator Study

5.1 Introduction

This chapter summarizes the preliminary findings obtained about the sample population for violator study using frequency distribution and cross tabulation. T-test and Chi-square test are also performed to find out the significantly different categorical variables between red light violators and control group. For the analysis of attitudinal part of questionnaire factor analysis is performed and attitudes of different groups of drivers are discussed briefly.

First, data was coded and checked thoroughly by frequency tables. After correcting few errors which resulted from miscoding, some initial analysis were conducted. The codes and explanation of the variables used in the analysis are given in Appendix E-2.

Driver characteristics, in terms of nationality, education, occupation, age, monthly income, marital status, driving school, driving experience, familiarity to the region, annual driven kilometers, vehicle type, license type, number of accidents and

offenses involved in, and the legal speed limit of highways and expressways are briefly discussed. Afterwards characteristics of the average drivers in the Eastern Province were derived.

To increase the reliability of data, 222 questionnaire are used for the derivation of driver's characteristics in Eastern Province and attitudinal analysis which included speed violators. The comparisons of the red light violators and control group and red light violators with control group without violation are discussed as this was the objective of this thesis.

5.2 Socio Economic Characteristics of drivers in Eastern Province

Tables in Appendix F show the frequency distribution of the Socio economic characteristics of the drivers in Eastern Province. The main points of these frequency distribution are listed below:

1. In order to investigate the social factors in relation to motoring offenses and accidents, it was necessary for the driver sample to include the drivers convicted of motoring offenses accident involved drivers, drivers with a clean record. Therefore, out of 222 respondent, seventy nine (35.6%) of the all drivers violated red light, sixty three (28.4%) are speed violators, and the rest (36%) are non-violators i.e. control group. Analysis of speed violators were not included, as this was one of the objective of the study.

2. Out of 222 interviewers, 140 were Saudis. It means Saudi drivers accounted for 63.1% of all drivers, the remaining 36.9% were drivers from 12 different countries. This is one of the factors which contributes to the safety problems in this region. All of these drivers came from very different behavioral patterns, customs, laws, educational backgrounds, beliefs, etc. and they speak different languages.
3. Over all, educational level of drivers in this region is quite good. 65.3% of all drives have education up to high school. Only 2.3% of drivers have no formal education.
4. 18.5% drivers reported their occupation as professional and managerial. The next highest occupation group was the student (16.2%). This is a very significant portion of the total driver population. They are young and the cause of some major accidents. This can be seen from the evidence that, the student comprise 16.2 % of the total sample but they are on the top of speed violator group with 25.4%. Interestingly, the third major occupation group was professional drivers.
5. 37.4% of all the drives were not married, this is mainly because of large percentage of young drivers and bachelor expatriates.
6. 43.2% of all drivers did not have any driver's training at all. Regarding years of driving experience, 6.8% of drivers have 1 to 2 years of driving experience. 74.3% of all drivers reported that they were earning less than SR. 5000 per month.

7. 50% of the drivers drive more than 25,000 km in a year, out of which 28.4% drive more than 50,000 km in a year, means more than 4000 km in a month, more than 125 km in a single day. The average annual number of kilometers driven is 30,000 km which is quite high. This is probably because of lack of regional shopping centers and lack of good public transportation system.
8. 71.7% of all drivers either have their own car or their family car which is an indication of increasing vehicle ownership in this region. 9.5% of all drivers lived less than 2 years in this area and they have less familiarity with this area.
9. 94.6% of all drivers have permanent driving license which is good indication and probably this is because of new strict rules and regulations. 2.7% drivers did not have driving license.
10. 28.9% of all drivers have been involved in at least one accident during last 2 years. 51.4% of all drivers have been involved in at least one accident during their life. This means that there is more than 50% chance that you will get involved in accidents in this area, and this is very high risk.
11. 46.4% of all drivers have been involved in at least one motoring offense other than parking offense in last 2 years. One respondent involved in 15 such offenses, another was involved in 11 offenses and one driver involved in 10 offenses in the last two years and still drive on the road. On such cases the license should be canceled or driver should be penalized not to drive for at least one or two years.
12. 24.8% of all drivers drive very close to vehicle in front of them. They leave less than 2 car length distance. 46.8% of all drives, do not know about the

exact speed on highways 28.4 % overestimate the speed on highways while 18.4% under estimate this speed on highways. Over speeding and under speeding on highways are major causes of accidents on highways. Research in the UK (Munden, 1966) indicated that drivers who habitually drive close to the median cruising speed on a highways are less often involved in the accidents than those drivers who tend to drive faster or those who drive slower.

13. Only 36.5% of all drivers know exactly about the legal speed on highways correctly. This is because of poorly placed poorly maintained and lack of speed limit signs on highways and probably lack of education. This also accounts for speed violation. 80% of all drivers know the legal speed limit of expressways.

Based on the preceding data, the characteristics of the average drivers in the Eastern Province of Saudi Arabia, are summarized as follows. The average age is approximately 31.4 years old. There is one non-Saudi driver out of three drivers. The majority of drivers have blue collar job, this is because of increasing business and trading activities in Eastern Province and existence of basic infrastructure. The average driver completed 11.75 years of schooling. The majority of the drivers own a car. The average distance traveled is about 30,000 km in a year. The majority of drivers that is 93.2% have 2 or more years experience. 57% of all drivers have no formal driving training. About 1 out of every two drivers have been involved in one or more accidents. Approximately 1 out of every 2 drivers involved in motoring offense other than parking offense in last 2 years. Two out of five drivers are single.

The average income of driver is about SR 4600 per month. The majority of drivers had permanent driving license.

5.3 Comparison of red light violator and control group

To have a further insight into the data, two type of comparisons were made, first the comparison of red light violators with all control group was made. Second, to have a true comparison between violators and non violators, the red light violators are compared with control group without violation. The significant categorical variables for both comparisons are given in Table 5.1.

5.3.1 Red light violators Vs All control group

Only two categorical variable i.e., 'familiarity with the area' and 'drive vehicle regularly' are found significant. The bar charts showing comparison of these significant categorical variables are plotted in Figure5.1 and Figure 5.2. The Figure 5.1 shows that 82.3% of red light violators are familiar with the area i.e. lived greater than 2 years in the area, as compared to 93.75% of control group. 17.7 % of red light violators are less familiar with area i.e. lived less than and equal to 2 years in the area which is 2.5 times the value of control group so it can be concluded that less familiarity is one of the reasons for red light violation.

Figure 5.2 compares the frequency of red light violators and control group for 'drive vehicle regularly' category. It is clearly seen from Figure 5.2 that all the red light violators i.e. 100% drive vehicle regularly while 95% of control group drives

Table 5.1: Significant categorical variables for comparison between Red light violators and Control group.

Categorical Variables	Chi-Square (Significance) for relation between red light violator and control group	
	All control group	Control group without violation
Familiarity of area	4.97 (0.026)	-
Drive regularly	4.1 (0.044)	4.12 (0.042)
Offenses in last 2 years	-	18.12 (0.001)
Distance between cars	-	8.87 (0.031)

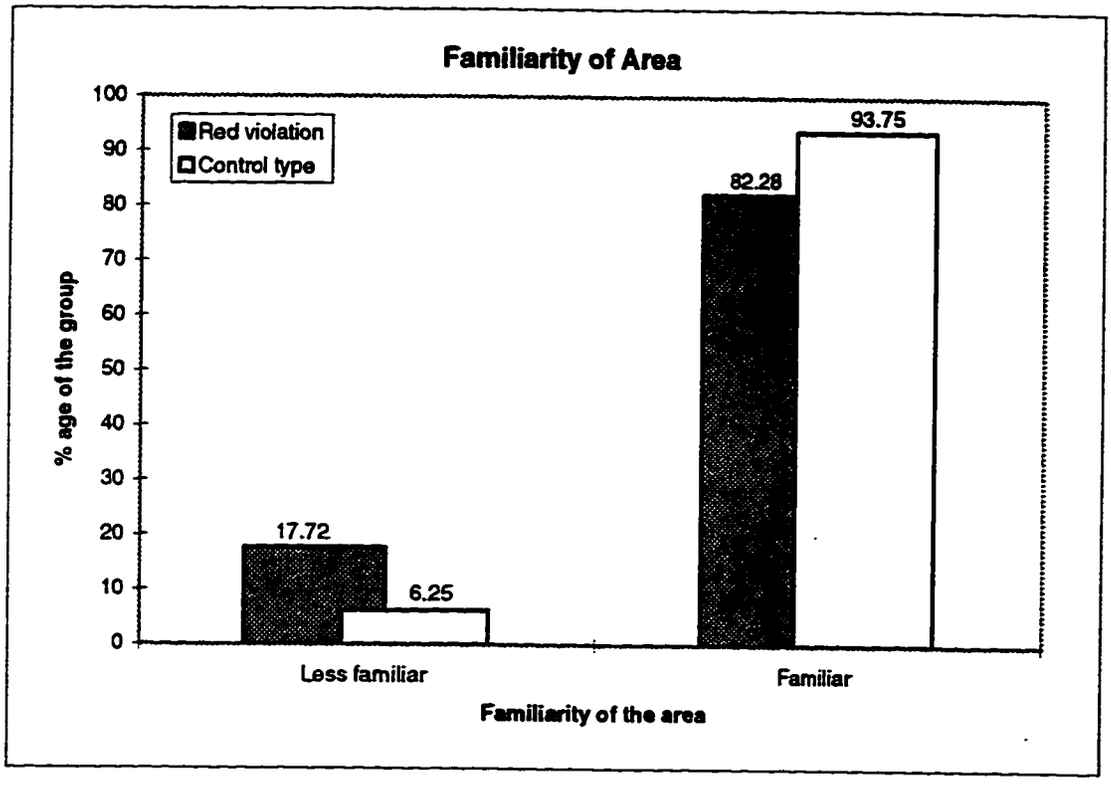

Figure 5.1: Comparison of red light violator and control group for familiarity of area

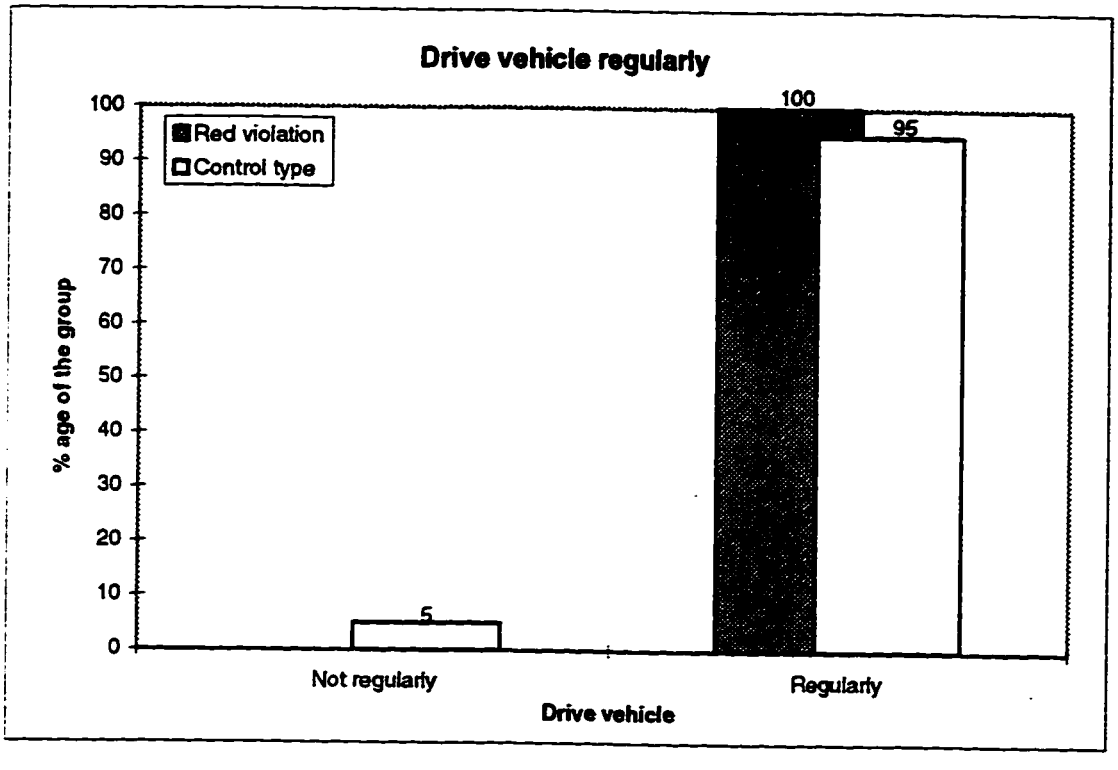

Figure 5.2: Comparison of red light violator and control group for drive vehicle regularly

regularly. It means that the red light violators have more exposure and more likelihood to commit motoring offense.

5.3.2 Red light violator vs control group without violation

In this section, red light violators were compared with control group without violation. The significant categorical variables for this comparison are given in Table 5.1. As can be seen, from the Table that, 3 variables i.e., 'drive vehicle regularly', 'motoring offense in last 2 years', and 'distance from other car', were found significant. The comparison of red light violator and control group without violation for these three categorical vehicle are given in Figure 5.3 through Figure 5.5.

From Figure 5.3, it can be seen that all of the red light violators drive vehicle regularly whereas 95% of control group without violation drive vehicle regularly. When comparing motoring offense it can be seen from Figure 5.4 that 64.56% of red light violators committed no motoring offense during the last 2 years. 13.92% of red light violators committed one motoring offense. Surprisingly, 7.59% committed 4 or more violations during last 2 years, which is very high percentage. To control this high percentage, special education programs are required, and better enforcement is needed.

Figure 5.5 compare the frequencies of "distance from car in front". 29.11% of red light violator leave less than 2 car length distance and another 49.37% of red light violator leave 2 to 3 car length distance between their vehicles and vehicle traveling in front of them. The percentage of control group for less than 2 car length and 2-3 car length distance is quite low as compared to red light violator group. The values of

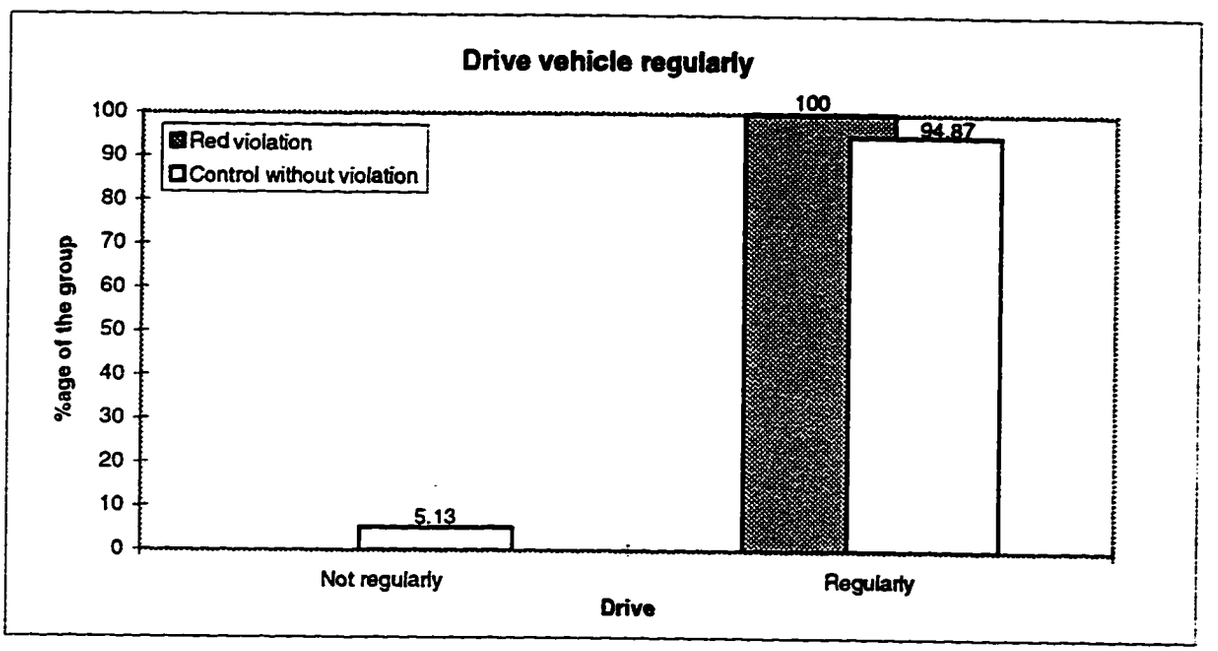

Figure 5.3: Comparison of red light violator and control group without violation for 'drive vehicle regularly' category

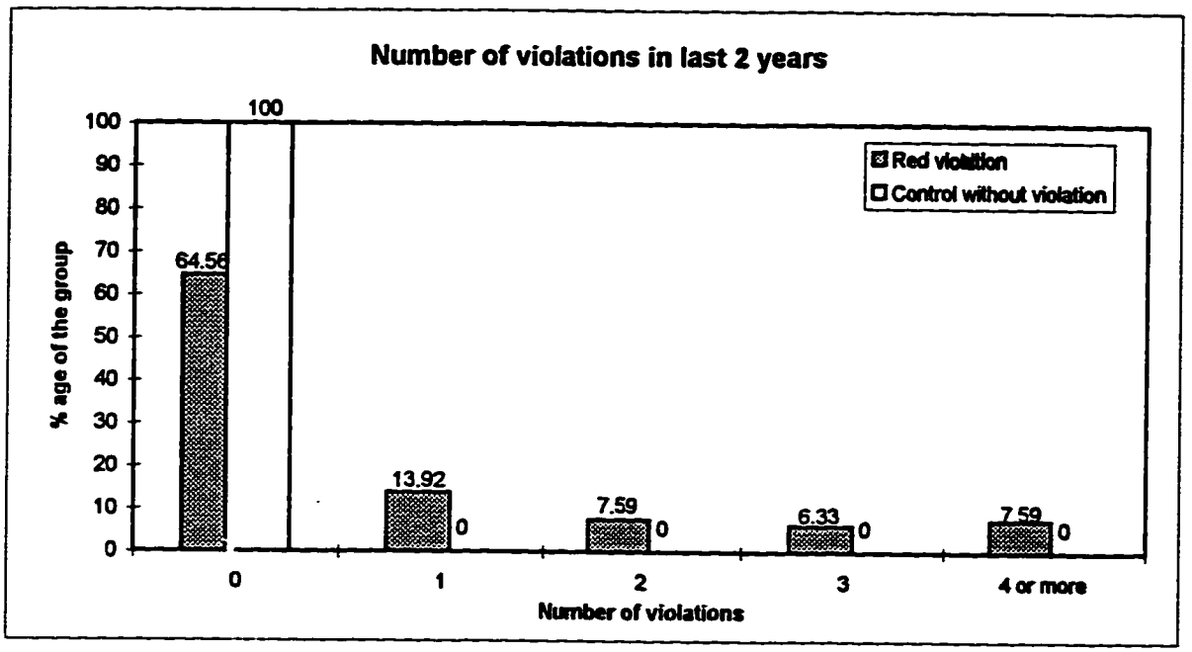

Figure 5.4: Comparison of red light violator and control group without violation for 'Motoring offense in last 2 years' category

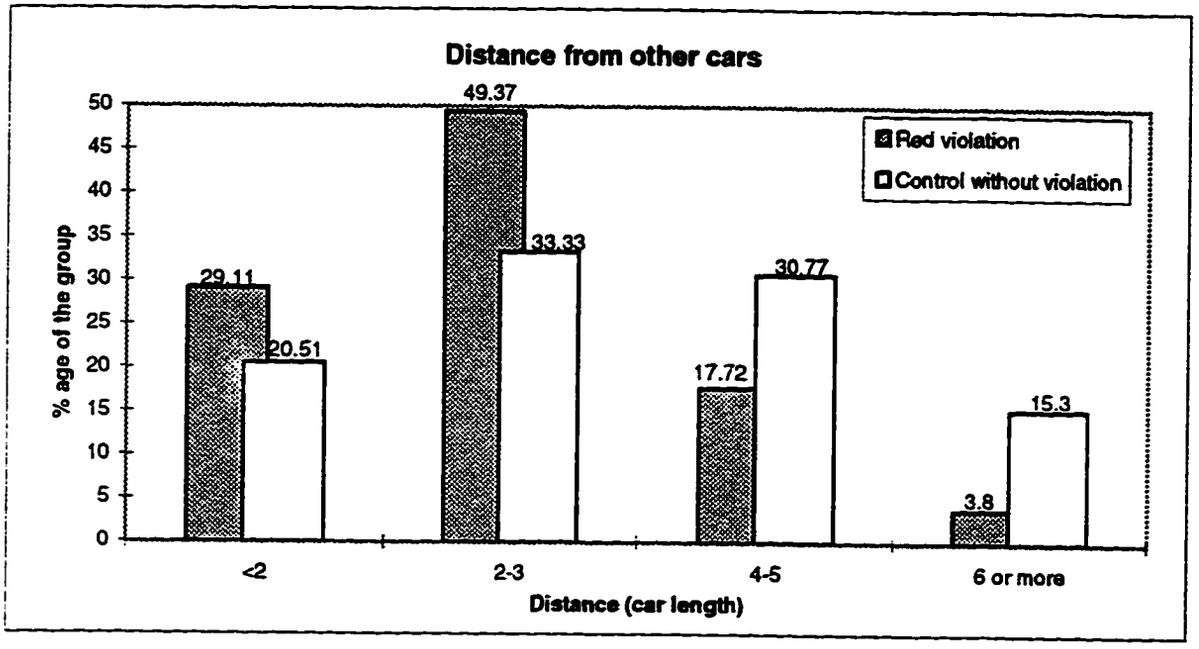

Figure 5.5: Comparison of red light violator and control group without violation for 'Distance from other cars' category

control group for these distance are 20.5% and 33.3 % respectively. When we compare 4 to 5 car length distance and six or more car length distance for red light violator and control group without violation the result is opposite i.e. the percentage of control group without violation is higher than the red light violators. The higher percentages of red light violator for less car length distances suggest the aggressiveness in the behavior of red light violators.

5.4 Attitudinal Scale Development

First, the means of 15 fundamental attitudinal attributes for control group and red light violators were obtained as presented in Table 5.2. By the help of these means a perceptual map of the fundamental attributes is drawn as shown in Figure 5.6. It can be seen from figure that there is no significant difference between the attitudes of red light violators and the attitudes of control group. However, applying factor analysis to these ratings will lead to a greater insights into the attitudes of red light violator and control group and will also show the various attributes link togather.

Factor analysis is used to reduce these attitudes to a smaller set of underlying cognitive dimensions, since single attitudes have low reliabilities. Applying factor analysis to these attitudes will lead to greater insights into the attitudes and also show how the various attributes link together.

For building attitudinal scales, common factor analysis without iterations and varimax rotation were used for two through six dimensions. The rotated factor loading matrices for two to six dimensions are presented in Appendix G.

Table 5.2: Average attribute rating for red and control group.

Attitudes	Average attribute rating	
	Red violators	Control group
1. One should always obey traffic laws.	1.36	1.25
2. There are too many unnecessary traffic signs and signals.	3.35	3.362
3. One should avoid taking risks on the roads.	1.65	1.49
4. I would rather accelerate than brake to get out of a difficult situation.	3.52	3.56
5. It is useless to check brakes, tires and brake lights on a regular basis.	3.89	4.28
6. There should be more traffic enforcement.	2.25	2.09
7. I like competing with other vehicles on roads.	4.05	4.15
8. I feel a bit anxious when I approach an intersection.	2.76	2.81
9. I like driving fast.	3.66	3.84
10. I don't feel safe when I drive on roads.	3.25	3.39
11. There is never any point in taking a chance.	2.33	2.06
12. In general, vehicles are well maintained in this area.	2.32	2.29
13. I wouldn't mind breaking a traffic law if it means getting out of a difficult situation.	3.44	3.15
14. It is sometimes a challenge to overtake the car in front of you.	3.35	3.34
15. Drivers in Saudi Arabia obey traffic rules in general.	2.52	3.00

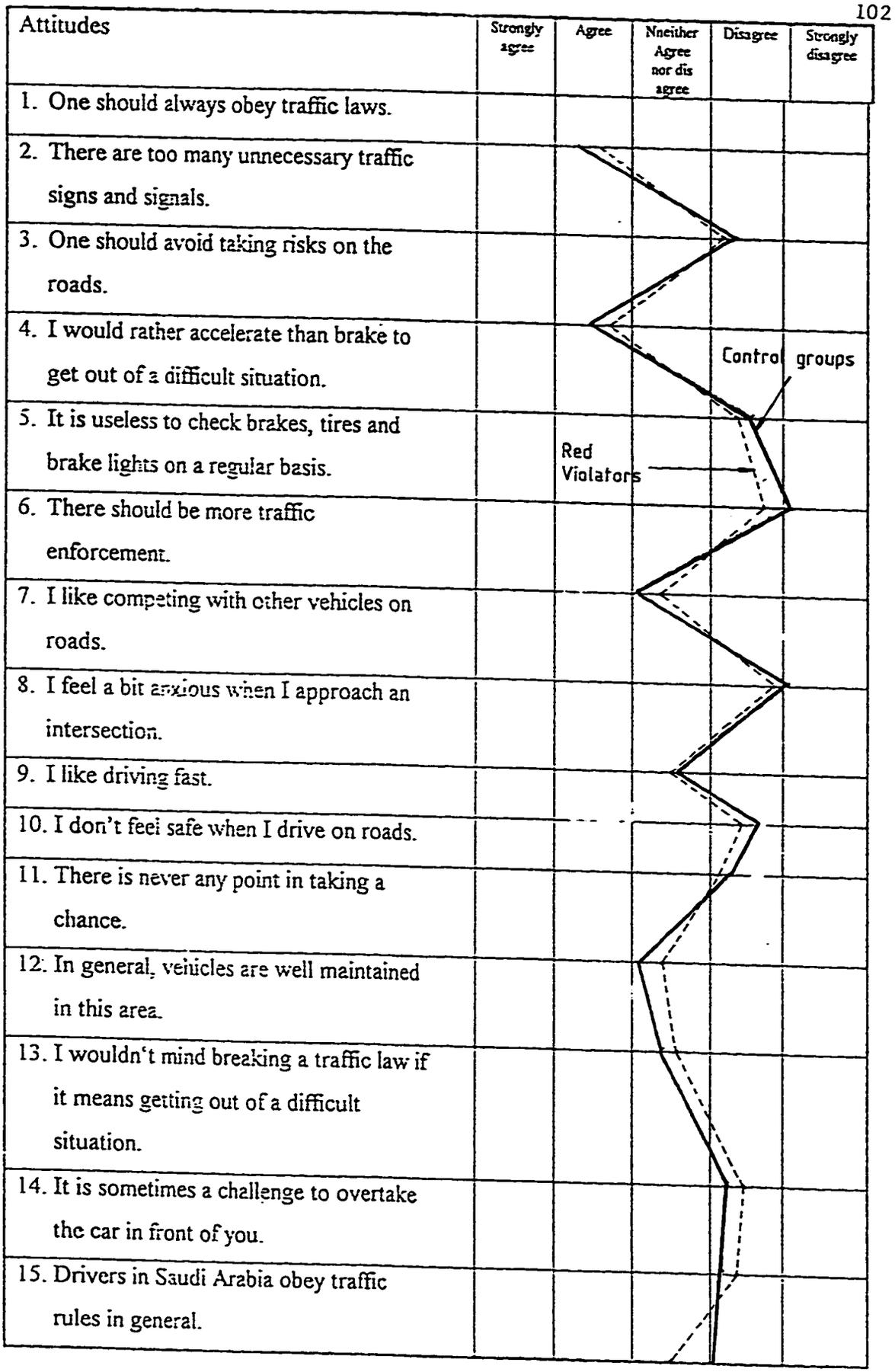

Figure 5.6: Snake plot of means for all attitudes.

The factors were named after the attitudinal items with high loading. Figure 5.7 show the splitting of factors in two through five dimensional solutions. Varimax rotation was applied in an attempt to improve interpretability.

In two factor solution, dimensions called 'Aggressive driving' and 'Defensive driving' were formed. On aggressive driving, dimension attitudes no 2,4,5,7 and 9 are loaded, and on defensive driving dimension attitude no 1,3, and 8 are loaded, the remaining attitudes have negligible loadings on these two factors, because their factors do not emerge at this stage, they emerge later on. As all attitudes do not have high loading on these two factors, the two factor solution does not seem to be a good one.

In three factor solution, a new dimension "System safety" is formed. Two attitudes i.e. attitude no 6 and attitude no 15 were loaded on this dimension. As all attitudes do not have loading of these 3 factors, the 3 factor solution was rejected for further analysis of attitudes.

In four factor solution, a new dimensions "road anxiety" was formed, Road anxiety is a combination of item 8,10 and 14. The loading on previous dimensions i.e. aggressive driving and defensive driving were also increased. Although, 4 factor solution seems reasonable, but five factor solution was also tried.

In five factor solution, Aggressive driving factor was split into 2 similar factors, defensive driving was also split into another factor with similar loading. System safety factor disappears completely. Number of items or attitudes per factor was reduce which reduces the reliability of the factors. Therefore four, factor solution is the best.

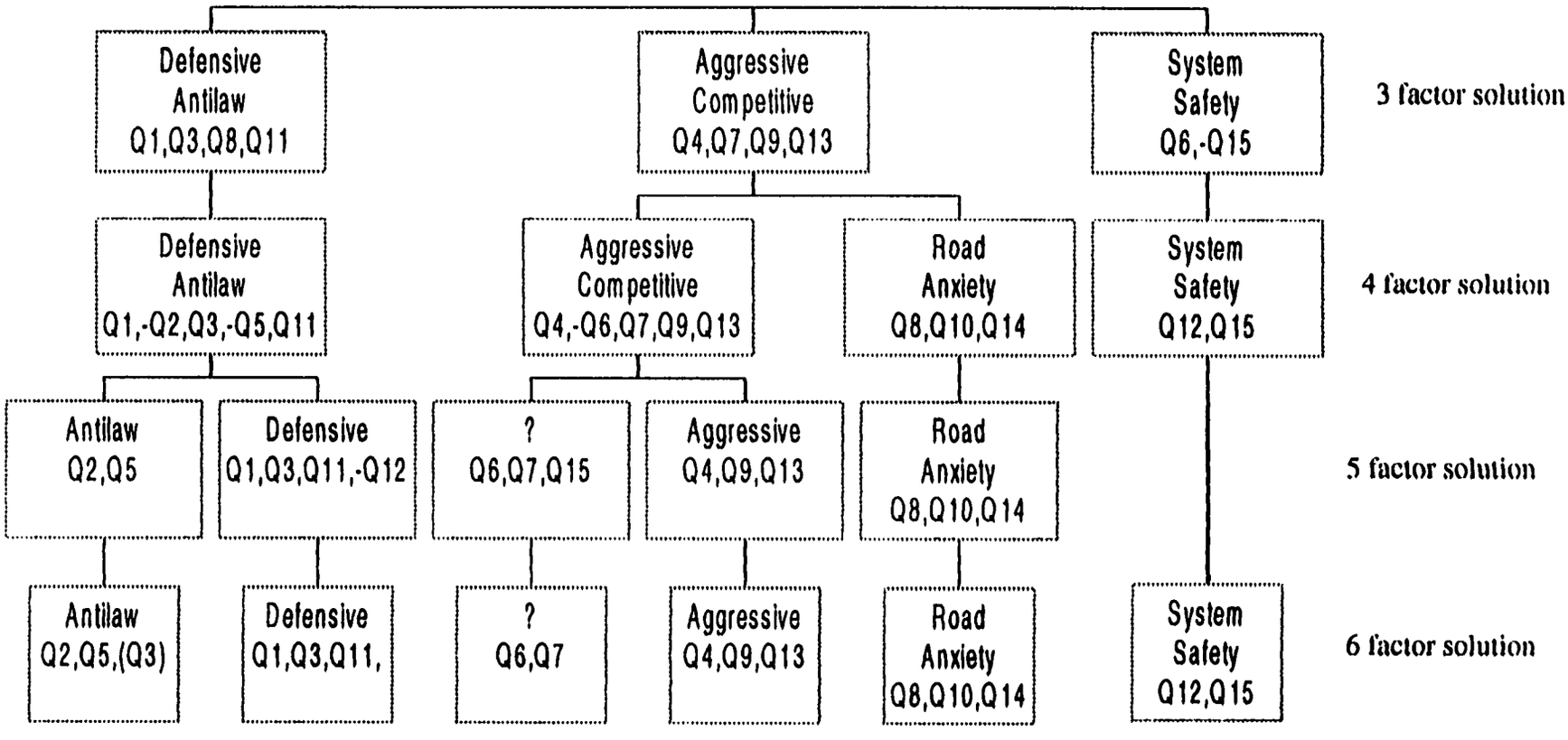

Figure 5.7: Final factor analysis.

As another check, to identify the best solution the Eigenvalue criteria was used. The Eigenvalues are presented in Table 5.3. The critical value for Eigenvalue is 1.0. This criteria suggest upto six factor solution. However, in term of interpretability four factor seems good, therefore, four factor solution was selected for further analysis of drivers.

5.5 Factor Scores

After selecting the four factor solution, means and standard deviation of the summarative scores of these factors for red light violators and control group were calculated and summarized in Table 5.4. As can be seen from the table, there is no significant difference between the means of all four factors for red light violator and control group. The factor means are also plotted on chart as shown in Figure 5.8. This Figure also suggest that there is no significant differences between the mean factor scores of red light violators and mean factor score of control group. Therefore, it can be concluded that there is no significant difference between the attitudes of red light violator and the attitudes of control group at signalized intersection.

Table 5.3: Eigenvalue for different numbers of factors.

Number of factors	Eigenvalue
1	2.30
2	2.03
3	1.37
4	1.23
5	1.10
6	1.07
7	0.89

Table 5.4: Mean factor scores of red light violator and control group.

Variable	Red light violators	Control group
AGGDRIVE	18.42	18.63
DEFDRIVE	10.14	9.16
RANXIETY	9.37	9.54
SYSAFETY	3.68	3.54

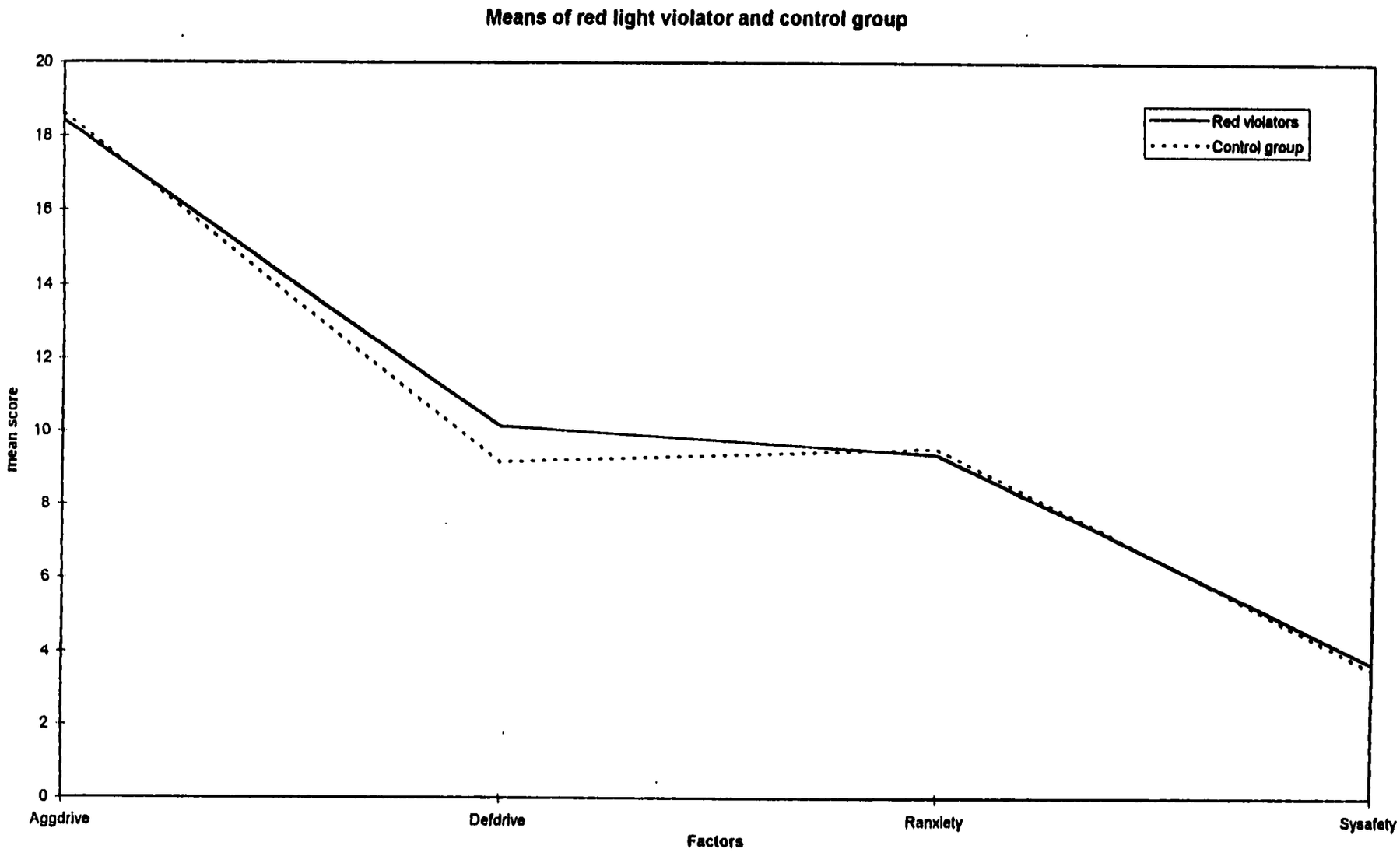

Figure 5.8: Snake plot of means of four factors for red light violators and contro group.

Chapter No 6

Conclusion and Recommendations

6.1 Conclusions

A number of conclusions can be summarized for these studies i.e. (violation study and violator study) The summary of the following conclusions are arranged in the order of the foregoing chapters.

1. On the average, 23.65 drivers cross the intersection at yellow, 10.58 cross on red, 23.63 start on red, 24.32 turn right on red with stopping and 34.6 turn right on red without stopping per hour. These frequencies are very high and shows the need for improvement.
2. Frightfully, 1.31 driver an hour crosses the street after the red light is on for 5 seconds. This is, probably the most dangerous violation and there are drivers who dare to do this.
3. Right turn on red violation rates were highest. Among the through vehicle violations, the highest rate was SRO (starting on red), followed by HNSY and HNSR.

4. Time of day, area, location, land use and street type had no effect on the violations.
5. Existence of median (MD_EXIST) seem to reduce right turn on red violation for reasons that are not very obvious. This might be because when there is a median, it is a major intersection and people may become more careful.
6. Existence of left turn lane affects all the violations, except HSOR, positively. It can be said that addition of left turn lane reduces the traffic violations.
7. Since existence of right turn lane decreases right turn on red with stopping (HRORWS). But it increase the right turn on red without stopping (HRORWOS). Therefore the overall benefit is questionable.
8. Existence of lane marking (LN_MARK) is beneficial because it decreases right turn on red without stop (HRORWS).
9. HNSR and HRORWOS seem to decrease as the no of lanes increases.
10. With the increase of thru lanes, starting on red (HSOR) violation increase and if pedestrian crossing exists HSOR violation decreases. This is a very logical result because driver will not want to have a conflict with pedestrians.
11. Improvement of sight distance is beneficial since it decreases HRORWS and ROR violations.
12. In our study area, i.e. Eastern Province, the red light violation is 7 to 10 times greater than that of USA value.
13. Eastern Province had the highest rate of not stopping on red violation when compared with Riyadh and USA.

14. Those who are unfamiliar to the area make more red light violations as compared to those who are familiar with the area.
15. 7.59% of red light violators committed 4 or more violations, 6.33% committed 3 violations , 7.59 % committed 2 violations and 13.92% committed one violation during last 2 years. These are very high percentages.
16. The driving attitudes of driver of Eastern province is grouped in to 4 main attitudes by means of factor analysis of attitudes. The 4 main groups are aggressive driving, defensive driving, road anxiety and system safety. The mean factor scores of these 4 groups suggested that there is no significant difference between the attitudes of red light violators and the attitudes of control group in the Eastern province of Saudi Arabia.

6.2 Recommendations

In the light of above conclusions the following recommendations can be made for decreasing violations and probably accidents, in intersections.

The seriousness of driver noncompliance with traffic rules and regulations is also seen from the large numbers of road accidents in the Kingdom of Saudi Arabia. To improve the compliance of traffic signals at intersection immediate implementation of a comprehensive program incorporating 3E's i.e. (Education, Enforcement and Engineering) is necessary.

Improvement such as higher enforcement levels at low traffic volume intersections, stiffer violation penalties, and educating the public of what constitutes a traffic signal violation should be considered.

As existence of left turn lane reduces all violations except starting on red (HSOR). Therefore, provision of left turn lane on every approach should be considered.

As existence of pedestrian crossing reduces starting on red violation (HSOR), therefore provision of pedestrian crossing on every approach should be considered.

As most of the people start driving at the age of 16 or 17, special courses or chapters should be include in the syllabus of high school students about highway safety or safe diving attitudes. The addition of course might help in improving the attitudes of drivers in Saudi Arabia.

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APPENDIX-A

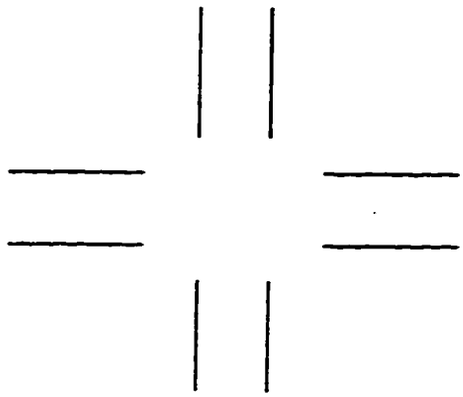
INTERSECTION INFORMATION FORM
TRAFFIC VIOLATION STUDY

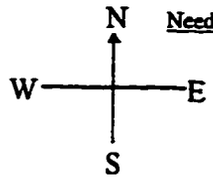
CROSSING STREETS _____ BY _____

INT. CODE: _____ AREA TYPE 1. CBD 2. FRINGE

LOCATION: 1. Al-Augrabia 2. Al-Khobar 3. Thuqba 4. Dammam 5. Qatif
LAND USE: 1. Residential 2. Commercial

SKETCH





Needed Detail
1. Names of streets
2. Auxiliary lanes (left right)
3. Number of lanes
4. Medians (traffic islands, etc.)
5. Delineation (lane marking, pedestrian crossing, stop lines, etc.)

APPROACH INFORMATION

Data Items	1. NORTH BOUND	2.WEST BOUND	3. SOUTH BOUND	4. EAST BOUND
Approach width (m)				
Median width (m)				
Median (0) Not Exist (1) Exist				
Left-turn Lane (0)Not Exist (1)Exist. one lane (2)Exist.2 lanes				
Exclusive Right-turn Lane (0) Not Eist (1) Exist				
Lane Marking: (0) Not Exist (1) Exist				
Number of Lanes				
Pedestrian Crossing: (0) Not Exist (1) Exist				
Type of Street (1) Arterial (2) Collector (3) Local				
Phasing of Signals: **During off-peak time:** Yellow time (S)- - - - - Red time (S) - - - - - - Green time (S) - - - - - - Cycle length (S) - - - - - -				
During peak time: Yellow time (S) - - - - - Red time (S) - - - - - - Green time (S) - - - - - Cycle length (S) - - - - - -				
During evening time: Yellow time (S) - - - - - Red time (S) - - - - - - Green time (S) - - - - - - Cycle length (S) - - - - - -				
Sight distance: (1) Good (2) Bad - - - - - - - -				
Pedestrian crossing activity: (1) Almost none (2) Light (3) Heavy - - - - -				

Designed by: Dr. Ergin

FIELD STUDY FOR RED SIGNAL AND YELLOW SIGNAL VIOLATION

Intersection_____Code_____

Performed by_____Date of study_____

Approach and Time	# of Vehicles whose drivers had free choice of stopping	# of drivers choosing not to stop at yellow	# of drivers choosing not to stop at red	# of drivers choosing not to stop after red signal has been on for more than 5 secs.	Starting on red (SOR)	Right turn on red with stop RTORS	Right turn on red without stop RTORWS	Total Volume Count			
NORTH								L	S	R	T
WEST											
SOUTH											
EAST											

SPOT SPEED SHEET

Intersection_____Code_____

Performed by_____Date of study_____

Time: _____

NORTH				WEST				SOUTH				EAST			
Posted Speed				Posted Speed				Posted Speed				Posted Speed			
S.No	Speed	S.No	Speed	S.No	Speed	S.No	Speed	S.No	Speed	S.No	Speed	S.No	Speed	S.No	Speed
1		37		1		37		1		37		1		37	
2		38		2		38		2		38		2		38	
3		39		3		39		3		39		3		39	
4		40		4		40		4		40		4		40	
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9		45		9		45		9		45		9		45	
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11		47		11		47		11		47		11		47	
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13		49		13		49		13		49		13		49	
14		50		14		50		14		50		14		50	
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25		61		25		61		25		61		25		61	
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32		68		32		68		32		68		32		68	
33		69		33		69		33		69		33		69	
34		70		34		70		34		70		34		70	
35		71		35		71		35		71		35		71	
36		72		36		72		36		72		36		72	

APPENDIX-B

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

Thank you for participating in this research project. This questionnaire is part of a study conducted by Civil Engineering Department of King Fahd University Of Petroleum and Minerals, Dhahran, Saudi Arabia for a research funded by King Abdul Aziz City of Science and Technology.

This is a study about the traffic violations and the attitudes of drivers toward certain issues related to traffic rules and regulations. As a participant you will be asked to respond to a series of questions about driving behavior and driving skill. All of your responses will be strictly confidential. In order to ensure your anonymity, you are not requested to give your name. The questionnaire takes about 10 minutes.

We appreciate your help and thank you for your cooperation.

Dr. S. N. Abduljauwad.
Chairman,
Civil Engineering Department.
King Fahd University of Petroleum and Minerals.

الظهران ٣١٢٦١ ● المملكة العربية السعودية ● تلفون : ٨٦٠-٢٥٥٠ (٠٣) ● فاكس : ٨٦٠-٢٨٧٩ (٠٣) ● تلكس : ٨٠١٩٥٠ حافهد ● برقياً : الجامعة
DHAHRAN 31261, SAUDI ARABIA ● Telephone : (03) 860-2550 ● Fax : (03) 860-2879 ● E-Mail : FACTOS@SAUPM00.BITNET

Questionnaire

TO BE FILLED BY INTERVIEWER:

Interviewer name: _____ Interview location: _____

Interview date: _____ Time: _____

Type of violation: _____

Type of vehicle: ☐ *Car* ☐ *Van* ☐ *Bus* ☐ *Truck* ☐ *Other*

PART-A

Direction: Please read each of the following statements and put an "X" in the appropriate box.

1. Did you learn to drive at a driving school?

☐ *yes* ☐ *No*

2. For how many years have you been driving? _____ *years.*

3. About how many Kilometers do you drive in a year.

☐ *Less than 15,000Km* ☐ *15,000 to 25,000 Km* ☐ *25,000 to 50,000 Km*
☐ *More than 50,000Km*

4. What vehicle do you normally drive?

☐ *Car* ☐ *Van* ☐ *Bus* ☐ *Truck* ☐ *Other* _____

(Please indicate)

5. Who owns the Vehicle you drive?

☐ *Myself* ☐ *Family* ☐ *Company* ☐ *Other* _____

(Please indicate)

6. For how long did you live in this region? _____ *years.*

7. Do you drive the vehicle regularly

For Pleasure	☐ *Yes*	☐ *No*	To go to work	☐ *Yes*	☐ *No*
At weekends	☐ *Yes*	☐ *No*	In your work	☐ *Yes*	☐ No
For holidays	☐ *Yes*	☐ *No*	For shopping	☐ Yes	☐ *No*

8. Did you have any road accidents while you were driving in the last two years?

☐ *Yes* ☐ *No*

If yes than how many accidents? _____

9. Have you had any accidents when you have been driving in your total driving experience?

☐ *Yes* ☐ *No*

If yes than how many accidents? _____

10. Have you ever been summoned for a motoring offense other than parking offense in the last 2 years.

☐ *Yes* ☐ *No*

If yes, how many times? _____ *times*

11. What is the fastest speed you would drive at on a clear highway?

☐ *60Kph* ☐ *90Kph* ☐ *120Kph* ☐ *150Kph* ☐ *180Kph or more*

12. When traveling at 60 Kph how many car lengths do you leave between yourself and the vehicle in front?

☐ *Less than two* ☐ *2 to 3* ☐ *4 to 5* ☐ *6 or more*

13. What is legal speed limit on urban streets? _____ *Kph.*

14. What is legal speed limit on expressways? _____ *Kph.*

PART-B

Please read each of the following statements and then put an "X" in the box that best describes how much you agree or disagree with each statement. PLEASE RESPOND TO ALL STATEMENTS.

	Strongly Agree	*Agree*	*Neither agree Nor Disagree*	*Disagree*	*Strongly Disagree*
1. One should always obey traffic laws.	☐	☐	☐	☐	☐
2. There are too many unnecessary traffic signs and signals.	☐	☐	☐	☐	☐
3. Roads needs better maintenance.	☐	☐	☐	☐	☐
4. One should avoid taking risks on the roads.	☐	☐	☐	☐	☐
5. I would rather accelerate than brake to get out of a difficult situation.	☐	☐	☐	☐	☐
6. Vehicle should be checked by government agency.	☐	☐	☐	☐	☐
7. It is useless to check breaks, tires and break lights on a regular basis.	☐	☐	☐	☐	☐
8. Traffic policemen are helpful.	☐	☐	☐	☐	☐
9. There should be more traffic control.	☐	☐	☐	☐	☐
10. Traffic signs and signals are well organized and maintained in this region.	☐	☐	☐	☐	☐
11. Persons below 18 years of age should not be allowed to drive.	☐	☐	☐	☐	☐
12. I like competing with other vehicles on the road	☐	☐	☐	☐	☐
13. One should always be alert for other drivers mistakes.	☐	☐	☐	☐	☐
14. Speeders should be penalized.	☐	☐	☐	☐	☐
15. I feel a bit anxious when I approach an intersection.	☐	☐	☐	☐	☐
16. There are too many unnecessary rules on the road.	☐	☐	☐	☐	☐

	Strongly Agree	*Agree*	*Neither agree Nor Disagree*	*Disagree*	*Strongly Disagree*
17.like driving fast.	☐	☐	☐	☐	☐
18.I don't feel safe when I drive on roads.	☐	☐	☐	☐	☐
19.Lots of accidents are caused mainly because of poorly maintained vehicles.	☐	☐	☐	☐	☐
20.Traffic signs and signals are well placed.	☐	☐	☐	☐	☐
21.Drivers in Saudi Arabia obeys traffic rules in general.	☐	☐	☐	☐	☐
22.In general, vehicles are well maintained in this area.	☐	☐	☐	☐	☐
23.Current driving licensing method is good.	☐	☐	☐	☐	☐
24.I wouldn't mind breaking a traffic law if it means getting out of a difficult situation.	☐	☐	☐	☐	☐
25.It is sometimes a challenge to overtake the car in front of you.	☐	☐	☐	☐	☐
26.There is never any point in taking a chance.	☐	☐	☐	☐	☐

PART-C

Directions: On this sheet you will find words which describe different kinds of moods and feelings. **Circle the words which describe how you generally feel nowadays.** Some of the words may sound alike, but we want you to check all the words that describe feelings. **Work Rapidly.**

1. active
2. afraid
3. agreeable
4. alive
5. alone
6. amiable
7. angry
8. awful
9. bitter
10. blue
11. calm
12. cheerful
13. clean
14. contended
15. contrary
16. cooperative
17. cruel
18. desperate
19. destroyed
20. disagreeable
21. discontented
22. discouraged
23. disgusted
24. enraged
25. enthusiastic
26. fearful
27. fit
28. neglected
29. free
30. friendly
31. frightened
32. furious
33. pleasure seeker
34. glad
35. gloomy
36. good
37. good-natured
38. happy
39. healthy
40. hopeless
41. inspired
42. interested
43. irritated
44. joyful
45. kindly
46. lonely
47. lost
48. loving
49. lucky
50. mad
51. mean
52. merry
53. miserable
54. nervous
55. offended
56. outraged
57. panicky
58. peaceful
59. pleasant
60. polite
61. rejected
62. sad
63. safe
64. secure
65. shaky
66. steady
67. stormy
68. strong
69. suffering
70. sympathetic
71. tame
72. tender
73. tense
74. terrible
75. terrified
76. thoughtful
77. tormented
78. understanding
79. unhappy
80. unsociable
81. upset
82. vexed
83. whole
84. willful
85. worrying
86. young.

PART D

Life Events Questionnaire

Directions: Read each life event and indicate if you have experienced the event in the last year. Mark an (X) in the space provided for each event which you have experienced in the last year.

Rank events

1. ☐ Death of spouse
2. ☐ Divorce
3. ☐ Marital separation
4. ☐ Jail term
5. ☐ Death of close family member
6. ☐ Personal injury or illness
7. ☐ Marriage
8. ☐ fired from Work
9. ☐ Marital reconciliation
10. ☐ Retirement
11. ☐ Change in family member's health
12. ☐ Pregnancy of wife
13. ☐ Sex difficulties
14. ☐ Addition to family
15. ☐ Business readjustment
16. ☐ Change in financial status
17. ☐ Death of close friend
18. ☐ Change to different line of work
19. ☐ Change in number of marital arguments
20. ☐ Mortgage or loan over SR.50,000
21. ☐ Application for a mortgage or a loan
22. ☐ Change in work responsibilities
23. ☐ Son or daughter leaving home
24. ☐ Trouble with in laws
25. ☐ Outstanding personal achievement
26. ☐ Spouse begins or stop work
27. ☐ Starting or finishing school
28. ☐ Change in living condition
29. ☐ Revision of personal habits
30. ☐ Trouble with boss
31. ☐ Change in work hour or work condition
32. ☐ Change in residence
33. ☐ Change in schools (for students)
34. ☐ Change in recreational habits
35. ☐ Change in religious activities
36. ☐ Change in social activities
37. ☐ Mortgage or loan under SR. 50,000
38. ☐ Change in sleeping habits
39. ☐ Change in eating habits
40. ☐ Increase or decrease in frequency of family meetings.
41. ☐ Minor violation of the law

PART-E

Directions: Please read each of the following statements and then put an "X" in the box that best descries you.

Nationality:

☐ *Saudi* ☐ *Pakistani/Indian* ☐ *Arabs*
☐ *Filipino* ☐ *American/European* ☐ *Other Gulf Countries*
☐ *Other* _____ *(Please indicate)*

Education:

☐ *No Formal Education* ☐ *Elementary level*
☐ *Intermediate Level* ☐ *University Degree*

Occupation:

☐ *Salesman* ☐ *Teacher/Professor* ☐ *Professional/Technical/Managerial*
☐ *Craftsman/Mechanic/Factory worker* ☐ *Clerical/Secretarial/Office worker*
☐ *Student* ☐ *Governmental* ☐ Retired ☐ *Other* _____ *(Please Specify)*

Age:

☐ *Less than 19* ☐ *20-29years* ☐ *30-39 years* ☐ *40-49 years*
☐ *50-59 years* ☐ *Over 60 years.*

Monthly Income:

☐ *Less than 2500 Sr.* ☐ *2500 to 5000 Sr.* ☐ *5000 to 10,000 Sr.*
☐ *10,000 to 20,000 Sr.* ☐ *Greater than 20,000 Sr.*

Would you say the present state of your health is good, fair or poor.

☐ *Good* ☐ *Fair* ☐ *Poor*

Do you get depressed easily?

☐ *Yes* ☐ *No*

Do you find things worrying you and getting on top of you sometimes?

☐ *Yes* ☐ *No*

Marital Status:

☐ *Single* ☐ *Married* ☐ *Widowed*
☐ *Divorced* ☐ *Separated*

If you are married, how many children you have? _____

Thank you very much for your cooperation.

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENGINEERING SCIENCES
CIVIL ENGINEERING DEPARTMENT

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية العلوم الهندسية
قسم الهندسة المدنية

Thank you for participating in this research project. This questionnaire is part of a study conducted by Civil Engineering Department of King Fahd University Of Petroleum and Minerals, Dhahran, Saudi Arabia for a research funded by King Abdul Aziz City of Science and Technology.

This is a study about the traffic violations and the attitudes of drivers toward certain issues related to traffic rules and regulations. As a participant you will be asked to respond to a series of questions about driving behavior and driving skill. All of your responses will be strictly confidential. In order to ensure your anonymity, you are not requested to give your name. The questionnaire takes about 10 minutes.

We appreciate your help and thank you for your cooperation.

Dr. S. N. Abduljauwad.
Chairman,
Civil Engineering Department.
King Fahd University of Petroleum and Minerals.

الظهران ٣١٢٦١ ● المملكة العربية السعودية ● تلفون : ٨٦٠-٢٥٥٠ (٠٣) ● فاكس : ٨٦٠-٢٨٧٩ (٠٣) ● تلكس : ٨٠١٩٥٠ جافهد ● برقياً : الجامعة

Questionnaire

TO BE FILLED BY INTERVIEWER:

Interviewer name: _____ **Interview location:** _____

Interview date: _____ **Time:** _____

Type of violation: _____

Type of vehicle: ☐*Car* ☐*Van* ☐*Bus* ☐*Truck* ☐*Other*

PART-A

Direction: Please read each of the following statements and put an "X" in the appropriate box.

1. Did you learn to drive at a driving school?

   ☐*yes* ☐*No*

2. For how many years have you been driving? _____*years.*

3. About how many Kilometers do you drive in a year.

   ☐*Less than 15,000 Km* ☐ *15,000 to 25,000 Km* ☐ *25,000 to 50,000 Km*
   ☐*More than 50,000 Km*

4. What vehicle do you normally drive?

   ☐*Car* ☐*Van* ☐*Bus* ☐*Truck* ☐*Other* _____

   (Please indicate)

5. Who owns the Vehicle you drive?

   ☐*Myself* ☐*Family* ☐*Company* ☐*Other* _____

   (Please indicate)

6. How long have you been living in this region? _____*years.*

7. Do you drive the vehicle regularly ☐*Yes* ☐*No*

8. Do you have a temporary driving license? ☐*Yes. How long?*_____*years.* ☐*No*

9. Do you have a permanent driving license? ☐*Yes, How long?*_____*years.* ☐*No*

10. Did you have any road accidents while you were driving in the last two years?

☐*Yes,* *How many accidents?*_____ ☐*No*

11. Have you had any accidents when you have been driving in your <u>total</u> driving experience?

☐*Yes,* *How many accidents?*_____ ☐*No*

12. Have you ever been cited for a motoring offense other than parking offense in the last 2 years.

☐*Yes,* *How many time(s)?*_____ ☐*No*

13. What is the fastest speed you would drive on a clear highway?

☐*60Kph* ☐*90Kph* ☐*120Kph* ☐*150Kph* ☐*180Kph or more*

14. When traveling at 60 Kph how many car lengths do you leave between yourself and the vehicle in front?

☐*Less than two* ☐*2 to 3* ☐*4 to 5* ☐*6 or more*

15. What is legal speed limit on urban streets? _____*Kph.*

16. What is legal speed limit on expressways? _____*Kph.*

PART-B

Please read each of the following statements and then put an "X" in the appropriate box that best describes your opinion. PLEASE RESPOND TO ALL STATEMENTS.

	Strongly Agree	*Agree*	*Neither agree Nor Disagree*	*Disagree*	*Strongly Disagree*
1. One should always obey traffic laws.	☐	☐	☐	☐	☐
2. There are too many unnecessary traffic signs and signals.	☐	☐	☐	☐	☐
3. One should avoid taking risks on the roads.	☐	☐	☐	☐	☐
4. I would rather accelerate than brake to get out of a difficult situation.	☐	☐	☐	☐	☐
5. It is useless to check brakes, tires and brake lights on a regular basis.	☐	☐	☐	☐	☐
6. There should be more traffic enforcement.	☐	☐	☐	☐	☐
7. I like competing with other vehicles on roads.	☐	☐	☐	☐	☐
8. I feel a bit anxious when I approach an intersection.	☐	☐	☐	☐	☐
9. I like driving fast.	☐	☐	☐	☐	☐
10. I don't feel safe when I drive on roads.	☐	☐	☐	☐	☐
11. There is never any point in taking a chance.	☐	☐	☐	☐	☐
12. In general, vehicles are well maintained in this area.	☐	☐	☐	☐	☐
13. I wouldn't mind breaking a traffic law if it means getting out of a difficult situation.	☐	☐	☐	☐	☐
14. It is sometimes a challenge to overtake the car in front of you.	☐	☐	☐	☐	☐
15. Drivers in Saudi Arabia obey traffic rules in general.	☐	☐	☐	☐	☐

PART-C

Directions: On this sheet you will find words which describe different kinds of moods and feelings. **Circle the words which describe how you generally feel nowadays.** Some of the words may sound alike, but we want you to check all the words that describe feelings. **Work Rapidly.**

- ☐ ١ – إيجابي active
- ☐ ٢ – خائف afraid
- ☐ ٣ – متقبل agreeable
- ☐ ٤ – حيوي alive
- ☐ ٥ – وحيد alone
- ☐ ٦ – ودود amiable
- ☐ ٧ – غاضب angry
- ☐ ٨ – فظيع awful
- ☐ ٩ – ممتعض bitter
- ☐ ١٠– منقبض blue
- ☐ ١١– هادىء calm
- ☐ ١٢– مبتهج cheerful
- ☐ ١٣– نقي clean
- ☐ ١٤– راض contented
- ☐ ١٥– مُعارض contrary
- ☐ ١٦– متعاون cooperative
- ☐ ١٧– قاسي cruel
- ☐ ١٨– يائس desperate
- ☐ ١٩– محطم destroyed
- ☐ ٢٠– رافض disagreable
- ☐ ٢١– غير راض discontented
- ☐ ٢٢– مخذول discouraged
- ☐ ٢٣– مشمئز disgusted
- ☐ ٢٤– ساخط enraged
- ☐ ٢٥– متحمس enthusiastic
- ☐ ٢٦– مخيف fearful
- ☐ ٢٧– كفء fit
- ☐ ٢٨– مُهمَل neglected
- ☐ ٢٩– حر free
- ☐ ٣٠– عشري friendly
- ☐ ٣١– مرعوب frightened
- ☐ ٣٢– ممتلىء غيظا furious
- ☐ ٣٣– باحث عن المتعة pleasure seeker
- ☐ ٣٤– مسرور glad
- ☐ ٣٥– مغموم gloomy
- ☐ ٣٦– جيد good
- ☐ ٣٧– دمث الخلق good natured
- ☐ ٣٨– سعيد happy
- ☐ ٣٩– معافى healthy
- ☐ ٤٠– بلا أمل hopeless
- ☐ ٤١– مُلهَم inspired
- ☐ ٤٢– مهتم interested
- ☐ ٤٣– مُستفز irritated
- ☐ ٤٤– مبتهج joyful
- ☐ ٤٥– رقيق kindly
- ☐ ٤٦– معزول lonely
- ☐ ٤٧– ضائع lost
- ☐ ٤٨– محب loving
- ☐ ٤٩– محظوظ lucky
- ☐ ٥٠– مجنون mad
- ☐ ٥١– جِلْف mean
- ☐ ٥٢– منشرح merry
- ☐ ٥٣– تعيس miserable
- ☐ ٥٤– عصبي nervous
- ☐ ٥٥– مغتاظ offended
- ☐ ٥٦– عنيف outraged
- ☐ ٥٧– مذعور panicky
- ☐ ٥٨– مسالم peaceful
- ☐ ٥٩– سار pleasant
- ☐ ٦٠– مؤدب polite
- ☐ ٦١– منبوذ rejected
- ☐ ٦٢– حزين sad
- ☐ ٦٣– آمن safe
- ☐ ٦٤– مطمئن secure
- ☐ ٦٥– مهزوز shaky
- ☐ ٦٦– ثابت steady
- ☐ ٦٧– هائج الطباع stormy
- ☐ ٦٨– قوى strong
- ☐ ٦٩– أقاسي suffering
- ☐ ٧٠– متعاطف sympathetic
- ☐ ٧١– أليف tame
- ☐ ٧٢– رقيق tender
- ☐ ٧٣– متوتر tense
- ☐ ٧٤– مرعب terrible
- ☐ ٧٥– مرعوب terrified
- ☐ ٧٦– مهتم بالآخرين thoughtful
- ☐ ٧٧– معذب tormented
- ☐ ٧٨– متفهم understanding
- ☐ ٧٩– غير سعيد unhappy
- ☐ ٨٠– غير اجتماعي unsociable
- ☐ ٨١– متضايق upset
- ☐ ٨٢– حانق vexed
- ☐ ٨٣– مستقر نفسيا whole
- ☐ ٨٤– قوي العزيمة willful
- ☐ ٨٥– مهموم worrying
- ☐ ٨٦– شاب (مفعم بالحيوية) young

H = D = A =

١٨/١٠/١٤١٧هـ

1. PART D

Life Events Questionnaire

Directions: Read each life event and indicate if you have experienced the event in the last year. Mark an (X) in the space provided for each event which you have experienced in the last year.

Rank events

1. ☐ Death of spouse
2. ☐ Divorce
3. ☐ Marital separation
4. ☐ Jail term
5. ☐ Death of close family member
6. ☐ Personal injury or illness
7. ☐ Marriage
8. ☐ fired from Work
9. ☐ Marital reconciliation
10. ☐ Retirement
11. ☐ Change in family member's health
12. ☐ Pregnancy of wife
13. ☐ Sex difficulties
14. ☐ Addition to family
15. ☐ Business readjustment
16. ☐ Change in financial status
17. ☐ Death of close friend
18. ☐ Change to different line of work
19. ☐ Change in number of marital arguments
20 ☐ Mortgage or loan over SR.50,000
21 ☐ Application for a mortgage or a loan
22. ☐ Change in work responsibilities
23. ☐ Son or daughter leaving home
24. ☐ Trouble with in laws
25. ☐ Outstanding personal achievement
26. ☐ Spouse begins or stop work
27. ☐ Starting or finishing school
28. ☐ Change in living condition
29. ☐ Revision of personal habits
30. ☐ Trouble with boss
31. ☐ Change in work hour or work condition
32. ☐ Change in residence
33. ☐ Change in schools (for students)
34. ☐ Change in recreational habits
35. ☐ Change in religious activities
36. ☐ Change in social activities
37. ☐ Mortgage or loan under SR. 50,000
38. ☐ Change in sleeping habits
39. ☐ Change in eating habits
40. ☐ Increase or decrease in frequency of family meetings.
41. ☐ Minor violation of the law

PART-E

Directions: Please read each of the following statements and then put an "X" in the box that best descries you.

Nationality:

☐ *Saudi* ☐ *Other Gulf Countries* ☐ *Pakistani/Indian*
☐ *Arabs* ☐ *Filipino* ☐ *American/European*
☐ *Other*_____ *(Please indicate).*

Education:

☐ *No Formal Education* ☐ *Elementary level* ☐ *Intermediate Level*
☐ *High school* ☐ *University Degree* ☐ *Other*_____ *(Please Specify)*

Occupation:

☐ *Salesman* ☐ *Teacher/Professor* ☐ *Professional/Managerial*
☐ *Craftsman/Mechanic/Factory worker* ☐ *Clerical/Secretarial/Office worker*
☐ *Student* ☐ Retired ☐ *Other* _____ *(Please Specify)*

Age:

☐ *Less than 18* ☐ *18-24 years* ☐ *25-30 years* ☐ *31-39 years* ☐ *40-49 years*
☐ *50-59 years* ☐ *Over 60 years.*

Monthly Income:

☐ *Less than 2500 Sr.* ☐ *2500 to 5000 Sr.* ☐ *5000 to 10,000 Sr.*
☐ *10,000 to 20,000 Sr.* ☐ *Greater than 20,000 Sr.*

Marital Status:

☐ *Single* ☐ *Married* ☐ *Widowed* ☐ *Divorced*

If you are married, how many children do you have? _____

Thank you very much for your cooperation.

APPENDIX-C

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	
Q1	0.71061	0.00502	-0.09263	0.16192	Always obey traffic laws
Q2	-0.21538	-0.39663	-0.04082	0.57061	too many traffic signs
Q3	-0.09406	-0.49635	0.33421	-0.19305	need better maintenanace
Q4	0.79169	-0.01947	0.03219	0.09636	Avoid taking risk
Q5	-0.54941	0.01295	0.12507	0.11208	rather accelerate than brake
Q6	0.56159	0.20494	0.45140	-0.05251	veh checked by govt agency
Q7	-0.07789	-0.00859	0.05398	0.64612	Useless to check brake and tires
Q8	0.15282	0.19374	0.64536	0.17519	Policemen are helpful
Q9	0.52129	0.02513	0.12642	-0.42202	more traffic control
Q10	-0.04471	0.81933	0.01453	-0.01249	Sign & signals are well organized
Q11	0.30129	0.49865	-0.11102	0.12644	below 18 should not allowed to drive
Q12	-0.69724	-0.21203	-0.07870	-0.13191	like competing with other vehicles
Q13	0.25687	0.09287	0.34350	-0.20508	Always be alert for other mistakes
Q14	0.66189	0.05943	0.25414	-0.13414	speeders should be penalised
Q15	0.50458	0.18909	-0.33911	-0.36171	Feel anxious when approach at X
Q16	-0.04776	-0.51315	-0.13446	0.31933	Too many rules on Roads
Q17	-0.65414	0.11263	-0.19956	-0.16061	I like driving fast
Q18	0.56059	-0.34940	-0.07544	-0.31199	I dont feel safe on roads
Q19	-0.05861	0.07628	0.51694	0.12901	Acc are caused by poorly maintained veh.
Q20	-0.28710	0.75548	0.22672	0.15493	Sign and signals are well placed
Q21	0.22321	-0.08081	0.30807	0.51276	Sriver in S.A. obey traffic rules
Q22	0.28648	0.14866	-0.36174	0.11673	Veh. are well maintained in this area
Q23	0.13432	0.28372	0.06175	0.55628	Driving Lic method is good
Q24	0.04405	0.14857	-0.03593	0.50773	I wouldnt mind breaking a traffic law
Q25	0.04666	0.02780	-0.49919	-0.01934	Challange to overtake the car
Q26	0.36426	-0.19845	0.68695	-0.01692	Never any point in taking a chance

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	
Q1	0.70234	0.01634	0.17214	-0.21706	0.08449	Always obey traffic laws
Q2	-0.15403	-0.36690	0.62473	0.07110	-0.06160	too many traffic signs
Q3	-0.05991	-0.47670	-0.21818	0.15215	-0.33199	need better maintenanace
Q4	0.79840	0.00563	0.10410	-0.19919	-0.03325	Avoid taking risk
Q5	-0.51303	-0.02522	0.02051	0.37780	0.01836	rather accelerate than brake
Q6	0.62930	0.22311	-0.14669	0.17466	-0.26269	veh checked by govt agency
Q7	0.01533	0.04146	0.70611	0.08627	-0.11897	Useless to check brake and tires
Q8	0.29650	0.26064	0.13691	0.32610	-0.52511	Policemen are helpful
Q9	0.47247	-0.04314	-0.59053	0.08990	0.12344	more traffic control
Q10	-0.02526	0.84786	0.03725	-0.04892	-0.01070	Sign & signals are well organized
Q11	0.28335	0.42649	-0.01341	0.13577	0.36643	below 18 should not allowed to drive
Q12	-0.69972	-0.13344	0.08037	-0.21671	-0.27185	like competing with other vehicles
Q13	0.27726	0.03419	-0.40782	0.35662	-0.01857	Always be alert for other mistakes
Q14	0.67277	0.02855	-0.27786	0.12596	-0.01912	speeders should be penalised
Q15	0.41332	0.25669	-0.14674	-0.70409	0.01013	Feel anxious when approach at X
Q16	-0.05268	-0.56825	0.23187	0.15971	0.21847	Too many rules on Roads
Q17	-0.68701	0.14059	-0.02371	-0.15524	-0.01601	I like driving fast
Q18	0.50567	-0.30928	-0.21683	-0.41655	-0.10912	I dont feel safe on roads
Q19	0.03687	0.02952	-0.09557	0.62324	-0.14229	Acc are caused by poorly maintained veh
Q20	-0.21280	0.76577	0.11814	0.28140	-0.08450	Sign and signals are well placed
Q21	0.32387	-0.10184	0.36302	0.41763	-0.05573	Sriver in S.A. obey traffic rules
Q22	0.21287	0.04241	-0.02687	0.03418	0.57446	Veh. are well maintained in this area
Q23	0.18998	0.19137	0.32139	0.49680	0.33786	Driving Lic method is good
Q24	0.10064	0.17048	0.53360	0.04414	0.02752	I wouldnt mind breaking a traffic law
Q25	-0.06829	-0.10400	-0.16423	0.01475	0.68751	Challange to overtake the car
Q26	0.48374	-0.13309	-0.06434	0.24963	-0.59264	Never any point in taking a chance

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	
Q1	0.74226	0.01813	0.22435	0.15696	0.01564	0.11700	Always obey traffic laws
Q2	-0.11959	-0.35154	-0.02256	0.65006	0.02062	-0.06239	too many traffic signs
Q3	-0.14545	-0.50959	-0.10982	-0.19690	0.28515	0.04610	need better maintenanace
Q4	0.68526	0.00751	0.41056	0.00731	0.23101	-0.07177	Avoid taking risk
Q5	-0.73841	-0.01983	0.10571	-0.01302	0.03131	-0.10125	rather accelerate than brake
Q6	0.37030	0.17955	0.29670	-0.19465	0.46645	0.23656	veh checked by govt agency
Q7	-0.04844	0.05510	0.13173	0.67532	0.18887	-0.10077	Useless to check brake and tires
Q8	0.01615	0.20902	0.13795	0.10160	0.68012	0.17919	Policemen are helpful
Q9	0.23857	-0.06161	0.36476	-0.64926	0.05079	0.12963	more traffic control
Q10	-0.06694	0.85487	0.05895	-0.03090	0.10028	-0.11821	Sign & signals are well organized
Q11	0.25082	0.42352	0.18546	0.03077	-0.26732	0.40453	below 18 should not allowed to drive
Q12	-0.33958	-0.13143	-0.69222	0.17567	-0.05685	-0.17804	like competing with other vehicles
Q13	0.10656	-0.01659	0.08228	-0.33997	0.09272	0.53976	Always be alert for other mistakes
Q14	0.49118	-0.00707	0.29328	-0.28454	0.18416	0.34959	speeders should be penalised
Q15	0.68401	0.28428	-0.06767	-0.22357	-0.04718	-0.38634	Feel anxious when approach at X
Q16	-0.15816	-0.54673	0.23472	0.22616	-0.17302	-0.03182	Too many rules on Roads
Q17	-0.36757	0.15109	-0.56893	0.06709	-0.25432	-0.08449	I like driving fast
Q18	0.64344	-0.31163	0.01622	-0.24173	0.08141	-0.12551	I dont feel safe on roads
Q19	-0.10855	-0.04113	0.11705	0.06775	0.14259	0.82151	Acc are caused by poorly maintained veh
Q20	-0.34980	0.75175	0.01376	0.10632	0.16639	0.12205	Sign and signals are well placed
Q21	-0.12251	-0.10571	0.61214	0.25540	0.35508	0.00205	Sriver in S.A. obey traffic rules
Q22	-0.03926	0.09353	0.65748	-0.16450	-0.32097	-0.23258	Veh. are well maintained in this area
Q23	-0.07990	0.18817	0.43203	0.34301	-0.13066	0.43504	Driving Lic method is good
Q24	0.19660	0.17076	-0.05333	0.59864	-0.04134	0.22876	I wouldnt mind breaking a traffic law
Q25	0.02419	-0.07227	0.10782	-0.09967	-0.70895	0.21989	Challange to overtake the car
Q26	0.23360	-0.19685	0.10631	-0.08057	0.71240	0.22576	Never any point in taking a chance

FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	FACTOR7	
0.68856	0.31411	-0.05801	0.09122	-0.03329	0.15986	-0.18457	Always obey traffic laws
-0.07407	-0.02493	-0.28219	0.74055	0.06048	-0.06202	0.23945	too many traffic signs
-0.08619	-0.03851	-0.30027	-0.02660	-0.13497	-0.08450	0.69854	need better maintenanace
0.61440	0.52757	-0.01374	-0.01596	-0.16918	-0.06362	-0.09457	Avoid taking risk
-0.77864	0.00847	-0.04172	-0.06241	-0.08299	-0.09187	-0.17094	rather accelerate than brake
0.32100	0.45592	0.24795	-0.18128	-0.32520	0.19062	0.14945	veh checked by govt agency
-0.07049	0.15957	0.03642	0.65659	-0.17134	-0.03086	-0.17823	Useless to check brake and tires
0.03784	0.31586	0.40524	0.23656	-0.40689	0.10289	0.46766	Policemen are helpful
0.18640	0.39934	-0.03652	-0.64165	0.04327	0.03799	0.15631	more traffic control
-0.03070	0.06201	0.86661	0.01193	0.05731	-0.10484	-0.11612	Sign & signals are well organized
0.23720	0.16546	0.33525	-0.02531	0.32851	0.42841	-0.16112	below 18 should not allowed to drive
-0.25015	-0.72928	-0.10098	0.20090	-0.10900	-0.13562	0.04786	like competing with other vehicles
0.15237	0.15675	0.13059	-0.21493	0.15131	0.40818	0.61728	Always be alert for other mistakes
0.38291	0.39912	-0.07668	-0.41051	-0.24569	0.35826	-0.18587	speeders should be penalised
0.70142	-0.01907	0.24390	-0.21403	0.02289	-0.36091	-0.16369	Feel anxious when approach at X
-0.21062	0.16436	-0.59635	0.18184	0.10545	-0.02478	-0.07016	Too many rules on Roads
-0.28842	-0.65946	0.12246	0.05814	0.11064	-0.03304	-0.10087	I like driving fast
0.64309	0.07846	-0.27604	-0.20427	-0.09161	-0.16217	0.17558	I dont feel safe on roads
-0.12403	-0.04224	-0.01549	0.01338	-0.14703	0.81095	0.17995	Acc are caused by poorly maintained veh.
-0.32784	0.01384	0.76788	0.11631	-0.04227	0.14390	-0.10032	Sign and signals are well placed
-0.20907	0.65969	-0.07135	0.25821	-0.20387	-0.02201	0.01133	Sriver in S.A. obey traffic rules
-0.04225	0.54242	0.10588	-0.05957	0.59493	-0.32075	0.13462	Veh. are well maintained in this area
-0.16719	0.39385	0.06427	0.21458	0.14061	0.49164	-0.33601	Driving Lic method is good
0.21869	-0.02199	0.14112	0.58842	0.07141	0.29102	-0.06756	I wouldnt mind breaking a traffic law
0.04355	-0.04839	-0.17045	-0.11789	0.71379	0.20579	-0.03413	Challange to overtake the car
0.15089	0.31245	-0.12220	-0.12496	-0.73210	0.21065	0.09896	Never any point in taking a chance

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	FACTOR7	FACTOR8
Q1	0.46241	0.58517	-0.08754	0.12534	-0.00910	0.18501	-0.17894	-0.04396
Q2	-0.10125	-0.06784	-0.22496	0.74082	0.07414	-0.04882	0.23797	0.14551
Q3	-0.06597	-0.08376	-0.32112	-0.02003	-0.12297	-0.08257	0.68824	0.05334
Q4	0.69957	0.42615	-0.08394	0.05405	-0.06022	-0.12365	-0.08851	-0.19345
Q5	-0.21849	-0.63270	0.12303	-0.11351	-0.16892	-0.08163	-0.14004	0.43568
Q6	0.57748	0.17227	0.17320	-0.14419	0.26442	0.14800	0.16292	-0.20133
Q7	0.13571	-0.12451	0.07138	0.67083	0.12858	-0.06243	-0.16740	0.00194
Q8	0.33718	-0.04988	0.35163	0.24882	-0.36812	0.07540	0.48825	-0.18942
Q9	0.42536	0.15262	-0.02461	-0.63024	0.03785	0.03957	0.17512	0.11994
Q10	-0.00753	0.06294	0.88236	-0.03289	-0.01410	-0.05861	-0.07519	-0.10140
Q11	0.12378	0.30942	0.41818	-0.07611	0.21221	0.53353	-0.12765	0.21597
Q12	-0.79343	-0.06788	-0.10072	0.15257	-0.20631	-0.05595	0.02540	0.04806
Q13	0.18117	0.10145	0.08576	-0.22240	0.14585	0.42540	0.61781	-0.06850
Q14	0.58280	0.19702	-0.15378	-0.35868	-0.17035	0.29797	-0.19208	-0.15935
Q15	0.05769	0.80493	0.22943	-0.22495	-0.06310	-0.24214	-0.14210	0.01493
Q16	-0.04578	-0.03183	-0.34612	0.131[illegible]	-0.04155	0.09611	-0.03051	0.82524
Q17	-0.69521	-0.17079	0.08565	0.02034	0.06232	-0.00794	-0.12904	-0.14039
Q18	0.16791	0.67664	-0.28511	-0.19324	-0.14093	-0.06906	0.18131	0.14189
Q19	-0.00154	-0.19471	-0.04545	-0.00252	-0.16383	0.80941	0.16509	-0.03785
Q20	-0.06921	-0.28155	0.77888	0.07397	-0.08412	0.14328	-0.07231	-0.13038
Q21	0.57727	-0.29962	0.03163	0.28146	-0.15207	-0.08207	0.05015	0.24066
Q22	0.35346	0.03635	0.27424	-0.08243	0.55271	-0.28315	0.18984	0.41640
Q23	0.36406	-0.27023	0.13580	0.21733	0.17142	0.44176	-0.32001	0.10416
Q24	-0.02773	0.23683	0.17502	0.56524	0.02277	0.35887	-0.05738	0.05496
Q25	0.00518	-0.07417	-0.22681	-0.08852	0.81727	0.12406	-0.07304	-0.22013
Q26	0.44605	0.00457	-0.19184	-0.07998	-0.67300	0.15901	0.09871	-0.10547

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	FACTOR7	FACTOR8	FACTOR9
Q1	0.56990	-0.08469	0.51086	0.14292	-0.00082	-0.06043	0.13075	0.18250	0.00653
Q2	-0.17268	-0.23784	-0.08278	0.75505	0.00776	0.10141	0.00587	-0.11710	0.11973
Q3	-0.01761	-0.28282	-0.15933	0.13332	-0.11488	0.35111	-0.66799	0.04480	0.10589
Q4	0.78886	-0.07380	0.32816	0.07945	-0.08600	-0.07156	-0.02973	-0.10399	-0.12323
Q5	-0.28930	0.15517	-0.57403	-0.15671	-0.13504	-0.25964	-0.04668	-0.01005	0.43986
Q6	0.56102	0.15349	0.10710	-0.11623	-0.33314	0.26123	0.01999	0.07508	-0.15597
Q7	0.24100	0.14848	-0.18605	0.67845	-0.06810	-0.39197	-0.10069	0.08142	0.07833
Q8	0.27612	0.34029	-0.10917	0.30997	-0.45934	0.39544	-0.16963	0.01480	-0.15430
Q9	0.39928	-0.05704	0.11831	-0.58623	-0.02438	0.31680	-0.06981	-0.03923	0.15362
Q10	-0.00396	0.87498	0.09745	-0.05536	-0.02414	0.00298	0.08571	-0.09118	-0.09386
Q11	0.25823	0.44501	0.26103	-0.02765	0.26616	0.07140	0.12453	-0.51835	0.30638
Q12	-0.83076	-0.10542	0.03709	0.11981	-0.13515	-0.12607	-0.07064	0.03775	-0.05970
Q13	0.10375	0.02753	0.05125	-0.12718	0.02725	0.80353	-0.02312	0.21000	-0.05339
Q14	0.68632	-0.12691	0.11188	-0.34047	-0.13491	-0.05176	0.05511	0.33762	-0.07272
Q15	0.13638	0.20008	0.82898	-0.22501	-0.03932	-0.09423	-0.03576	-0.18871	-0.01778
Q16	-0.11331	-0.35396	-0.01337	0.12961	-0.05597	-0.07683	0.03899	0.08405	0.81811
Q17	-0.52879	0.16992	-0.13926	0.04403	0.24373	-0.33869	-0.28764	0.24028	-0.12672
Q18	0.19056	-0.32392	0.65699	-0.14307	-0.16299	0.17913	-0.14621	-0.05849	0.11711
Q19	0.03520	-0.01739	-0.25069	0.05042	-0.12494	0.28338	0.07584	0.78157	0.02488
Q20	-0.09510	0.78719	-0.25102	0.03984	-0.08645	0.00278	0.15131	0.10020	-0.11376
Q21	0.36743	-0.02319	-0.31143	0.22310	-0.32530	0.13298	0.29448	-0.29530	0.23359
Q22	0.30577	0.24446	0.00468	-0.03639	0.[illegible]3292	0.25093	-0.05246	-0.43191	0.46506
Q23	0.18107	0.06729	-0.24837	0.09760	[illegible]0852	0.10792	0.79074	0.11502	0.07961
Q24	-0.09621	0.12772	0.25255	0.52277	-0.03853	0.12958	0.43287	0.18612	0.01197
Q25	0.09300	-0.21305	-0.12403	-0.05916	0.82254	0.10622	0.11136	0.03697	-0.17146
Q26	0.36169	-0.21349	-0.02423	-0.09571	-0.72252	0.10357	0.04318	0.14111	-0.11027

APPENDIX-D

2

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 144

	HFREECH	HNSY	HNSR	HNSR5SEC	HSOR	HRORWS	HRORWOS	ROR	TOTVIOL	AP_WIDTH	MD_WIDTH	HVOL_LFT
HFREECH	1.00000 0.0	0.40077 0.0001	0.41636 0.0001	0.20147 0.0155	0.66242 0.0001	-0.06419 0.4446	0.23880 0.0039	0.12850 0.1248	0.46790 0.0001	0.86998 0.0001	0.49002 0.0001	0.54459 0.0001
HNSY	0.40077 0.0001	1.00000 0.0	0.82559 0.0001	0.41066 0.0001	0.23595 0.0044	0.06314 0.4521	0.15230 0.0684	0.14060 0.0928	0.67878 0.0001	0.31793 0.0001	0.04286 0.6100	0.34792 0.0001
HNSR	0.41636 0.0001	0.82559 0.0001	1.00000 0.0	0.37904 0.0001	0.24226 0.0034	-0.03458 0.6807	0.12057 0.1500	0.06366 0.4484	0.59775 0.0001	0.33590 0.0001	0.10967 0.1907	0.38661 0.0001
HNSR5SEC	0.20147 0.0155	0.41066 0.0001	0.37904 0.0001	1.00000 0.0	0.09473 0.2587	0.01359 0.8716	0.06266 0.4556	0.05087 0.5449	0.31394 0.0001	0.29087 0.0004	0.27786 0.0007	0.20470 0.0138
HSOR	0.66242 0.0001	0.23595 0.0044	0.24226 0.0034	0.09473 0.2587	1.00000 0.0	0.09875 0.2390	0.26147 0.0015	0.23595 0.0044	0.52017 0.0001	0.48978 0.0001	0.18707 0.0248	0.39340 0.0001
HRORWS	-0.06419 0.4446	0.06314 0.4521	-0.03458 0.6807	0.01359 0.8716	0.09875 0.2390	1.00000 0.0	0.26638 0.0013	0.74714 0.0001	0.53093 0.0001	-0.07069 0.3998	-0.01927 0.8187	0.07611 0.3646
HRORWOS	0.23880 0.0039	0.15230 0.0684	0.12057 0.1500	0.06266 0.4556	0.26147 0.0015	0.26638 0.0013	1.00000 0.0	0.83968 0.0001	0.69242 0.0001	0.12740 0.1281	-0.06799 0.4181	0.13201 0.1147
ROR	0.12850 0.1248	0.14060 0.0928	0.06366 0.4484	0.05087 0.5449	0.23595 0.0044	0.74714 0.0001	0.83968 0.0001	1.00000 0.0	0.77663 0.0001	0.04802 0.5676	-0.05774 0.4918	0.13392 0.1096
TOTVIOL	0.46790 0.0001	0.67878 0.0001	0.59775 0.0001	0.31394 0.0001	0.52017 0.0001	0.53093 0.0001	0.69242 0.0001	0.77663 0.0001	1.00000 0.0	0.33370 0.0001	0.05210 0.5351	0.30403 0.0001
AP_WIDTH	0.86998 0.0001	0.31793 0.0001	0.33590 0.0001	0.29087 0.0004	0.48978 0.0001	-0.07069 0.3998	0.12740 0.1281	0.04802 0.5676	0.33370 0.0001	1.00000 0.0	0.55548 0.0001	0.60726 0.0001
MD_WIDTH	0.49002 0.0001	0.04286 0.6100	0.10967 0.1907	0.27786 0.0007	0.18707 0.0248	-0.01927 0.8187	-0.06799 0.4181	-0.05774 0.4918	0.05210 0.5351	0.55548 0.0001	1.00000 0.0	0.18281 0.0283
HVOL_LFT	0.54459 0.0001	0.34792 0.0001	0.38661 0.0001	0.20470 0.0138	0.39340 0.0001	0.07611 0.3646	0.13201 0.1147	0.13392 0.1096	0.30403 0.0001	0.60726 0.0001	0.18281 0.0283	1.00000 0.0
HVOL_ST	0.75812 0.0001	0.53614 0.0001	0.62902 0.0001	0.32274 0.0001	0.42116 0.0001	0.05996 0.4753	0.12554 0.1330	0.05279 0.5298	0.45582 0.0001	0.73235 0.0001	0.53939 0.0001	0.38678 0.0001
HVOL_RGT	0.10324 0.2182	0.10106 0.2281	0.06918 0.4100	0.01042 0.9014	0.24051 0.0037	0.36782 0.0001	0.42140 0.0001	0.49784 0.0001	0.43267 0.0001	0.07040 0.4018	0.00506 0.9520	0.09490 0.2579
HVOL_TOT	0.75147 0.0001	0.52743 0.0001	0.59283 0.0001	0.29755 0.0003	0.51787 0.0001	0.12115 0.1481	0.28589 0.0005	0.26541 0.0013	0.60704 0.0001	0.74614 0.0001	0.43244 0.0001	0.67237 0.0001
HVOLTHRU	0.80421 0.0001	0.55285 0.0001	0.63942 0.0001	0.33078 0.0001	0.48555 0.0001	-0.01273 0.8776	0.15103 0.0708	0.09697 0.2476	0.50803 0.0001	0.81153 0.0001	0.48483 0.0001	0.71854 0.0001
RTIME	-0.04402 0.6003	0.15200 0.0690	0.14831 0.0761	0.09041 0.2812	0.18074 0.0300	0.10291 0.2196	0.09165 0.2746	0.12119 0.1479	0.20763 0.0125	-0.09417 0.2615	0.17734 0.0335	0.20880 0.0120

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 144

	HFREECH	HNSY	HNSR	HNSR5BEC	HSOR	HRORWB	HRORWOB	ROR	TOTVIOL	AP_WIDTH	MD_WIDTH	HVOL_LFT
GTIME	0.65381 0.0001	0.36922 0.0001	0.47551 0.0001	0.26421 0.0014	0.42103 0.0001	-0.09046 0.2809	0.09178 0.2739	0.01232 0.8834	0.33787 0.0001	0.66336 0.0001	0.28150 0.0006	0.44588 0.0001
CYCTIME	0.37863 0.0001	0.36805 0.0001	0.43309 0.0001	0.24697 0.0028	0.42670 0.0001	0.02916 0.7286	0.13804 0.0970	0.11218 0.1807	0.39583 0.0001	0.33563 0.0001	0.33544 0.0001	0.46409 0.0001
HFREECH	1.00000 0.0	0.40077 0.0001	0.41636 0.0001	0.20147 0.0155	0.46242 0.0001	-0.06419 0.4446	0.23080 0.0039	0.12850 0.1248	0.46790 0.0001	0.86998 0.0001	0.49002 0.0001	0.54459 0.0001
MEAN	0.36234 0.0001	0.20293 0.0072	0.19928 0.0166	0.13522 0.1061	0.19715 0.0179	-0.00960 0.9091	0.02873 0.7325	0.01440 0.8640	0.17810 0.0327	0.43472 0.0001	0.22910 0.0057	0.31280 0.0001
STDD_DEV	0.17831 0.0325	0.20399 0.0142	0.20632 0.0131	0.10386 0.2154	0.12827 0.1288	0.05204 0.5356	0.09295 0.2678	0.09342 0.2654	0.20737 0.0126	0.17159 0.0397	0.13296 0.1121	0.13009 0.1202
V15THPER	0.35477 0.0001	0.18369 0.0275	0.16499 0.0481	0.09882 0.2387	0.18690 0.0249	-0.02698 0.7482	0.00365 0.9654	-0.01269 0.8800	0.13590 0.1043	0.43812 0.0001	0.21629 0.0092	0.33461 0.0001
V85THPER	0.36429 0.0001	0.24267 0.0034	0.21718 0.0089	0.15027 0.0722	0.17946 0.0314	-0.00435 0.9587	0.05545 0.5092	0.03578 0.6702	0.19914 0.0167	0.43532 0.0001	0.24849 0.0027	0.30076 0.0002

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Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 144

	HVOL_ST	HVOL_RBT	HVOL_TBT	HVOLTHRU	RTIME	GTIME	CYCTIME	HFREECH	MEAN	STDD_DEV	V15THPER	V85THPER
HFREECH	0.75812 0.0001	0.10324 0.2182	0.75147 0.0001	0.80421 0.0001	-0.04402 0.6003	0.65381 0.0001	0.37063 0.0001	1.00000 0.0	0.36234 0.0001	0.17831 0.0325	0.35477 0.0001	0.36429 0.0001
HNSY	0.53614 0.0001	0.10106 0.2281	0.52743 0.0001	0.55285 0.0001	0.15200 0.0690	0.36922 0.0001	0.36805 0.0001	0.40077 0.0001	0.22293 0.0072	0.20399 0.0142	0.18369 0.0275	0.24267 0.0034
HNSR	0.62902 0.0001	0.06918 0.4100	0.59283 0.0001	0.63942 0.0001	0.14831 0.0761	0.47551 0.0001	0.43309 0.0001	0.41636 0.0001	0.19928 0.0166	0.20632 0.0131	0.16499 0.0481	0.21718 0.0089
HNSR5SEC	0.32274 0.0001	0.01042 0.9014	0.29755 0.0003	0.33078 0.0001	0.09041 0.2812	0.26421 0.0014	0.24697 0.0028	0.20147 0.0155	0.13522 0.1061	0.10386 0.2154	0.09882 0.2387	0.15027 0.0722
HSDR	0.42116 0.0001	0.24051 0.0037	0.51787 0.0001	0.48555 0.0001	0.18094 0.0300	0.42102 0.0001	0.42670 0.0001	0.46242 0.0001	0.19715 0.0179	0.12827 0.1255	0.18690 0.0249	0.17946 0.0314
HROKWS	-0.05996 0.4753	0.36782 0.0001	0.12115 0.1481	-0.01273 0.8796	0.10291 0.2196	-0.09046 0.2809	0.02916 0.7286	-0.06419 0.4446	-0.00960 0.9091	0.05204 0.5356	-0.02698 0.7482	-0.00435 0.9587
HROKWDS	0.12554 0.1338	0.42140 0.0001	0.28589 0.0005	0.15103 0.0708	0.09165 0.2746	0.09178 0.2739	0.13884 0.0970	0.23880 0.0039	0.02873 0.7325	0.09295 0.2678	0.00365 0.9654	0.05545 0.5092
ROR	0.05279 0.5298	0.49784 0.0001	0.26541 0.0013	0.09697 0.2476	0.12119 0.1479	0.01232 0.8834	0.11218 0.1807	0.12850 0.1240	0.01440 0.8640	0.09342 0.2654	-0.01269 0.8800	0.03578 0.6702
TOTVIOL	0.45582 0.0001	0.43267 0.0001	0.60704 0.0001	0.50803 0.0001	0.20763 0.0125	0.33787 0.0001	0.39583 0.0001	0.46790 0.0001	0.17810 0.0327	0.20737 0.0126	0.13590 0.1043	0.19914 0.0167
AP_WIDTH	0.73235 0.0001	0.07040 0.4018	0.74614 0.0001	0.81153 0.0001	-0.09417 0.2615	0.66336 0.0001	0.33583 0.0001	0.86998 0.0001	0.43472 0.0001	0.17159 0.0397	0.43812 0.0001	0.43532 0.0001
MD_WIDTH	0.53939 0.0001	0.00506 0.9520	0.43244 0.0001	0.48483 0.0001	0.17734 0.0338	0.28150 0.0006	0.33544 0.0001	0.49002 0.0001	0.22910 0.0037	0.13296 0.1121	0.21629 0.0092	0.24849 0.0027
HVOL_LFT	0.38678 0.0001	0.09490 0.2579	0.67237 0.0001	0.71854 0.0001	0.20080 0.0120	0.44588 0.0001	0.46409 0.0001	0.54459 0.0001	0.31280 0.0001	0.13009 0.1202	0.33461 0.0001	0.30076 0.0002
HVOL_ST	1.00000 0.0	0.11510 0.1675	0.85794 0.0001	0.91927 0.0001	-0.00516 0.9511	0.81692 0.0001	0.51257 0.0001	0.75812 0.0001	0.35172 0.0001	0.21766 0.0080	0.32135 0.0001	0.37659 0.0001
HVOL_RBT	0.11510 0.1675	1.00000 0.0	0.47319 0.0001	0.12731 0.1284	0.16176 0.0527	0.04989 0.5526	0.17179 0.0325	0.10324 0.2182	0.05869 0.4847	0.07817 0.3517	0.03943 0.6309	0.07109 0.3910
HVOL_TBT	0.85794 0.0001	0.47319 0.0001	1.00000 0.0	0.93403 0.0001	0.13396 0.1094	0.73422 0.0001	0.50116 0.0001	0.75147 0.0001	0.37533 0.0001	0.22337 0.0071	0.35631 0.0001	0.39217 0.0001
HVOLTHRU	0.91927 0.0001	0.12731 0.1284	0.93403 0.0001	1.00000 0.0	0.08524 0.3097	0.80643 0.0001	0.54466 0.0001	0.80421 0.0001	0.39878 0.0001	0.21968 0.0082	0.38518 0.0001	0.41240 0.0001
RTIME	-0.00516 0.9511	0.16176 0.0527	0.13396 0.1094	0.08524 0.3097	1.00000 0.0	-0.13907 0.0964	0.78147 0.0001	-0.04402 0.6003	-0.02911 0.7290	0.07380 0.3794	-0.03140 0.7087	-0.02328 0.7818

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Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 144

	HVOL_ST	HVOL_RGT	HVOL_TOT	HVOLTHRU	RTIME	GTIME	CYCTIME	HFREECH	MEAN	STDD_DEV	V15THPER	V85THPER
GTIME	0.81692 0.0001	0.04989 0.5526	0.73422 0.0001	0.80643 0.0001	-0.13907 0.0964	1.00000 0.0	0.50705 0.0001	0.65381 0.0001	0.43228 0.0001	0.15185 0.0692	0.43034 0.0001	0.44172 0.0001
CYCTIME	0.51257 0.0001	0.17179 0.0395	0.58116 0.0001	0.58466 0.0001	0.78167 0.0001	0.50705 0.0001	1.00000 0.0	0.37863 0.0001	0.24799 0.0027	0.15942 0.0563	0.24457 0.0031	0.25911 0.0017
HFREECH	0.75812 0.0001	0.10324 0.2182	0.75147 0.0001	0.80421 0.0001	-0.04402 0.6003	0.65381 0.0001	0.37863 0.0001	1.00000 0.0	0.36234 0.0001	0.17831 0.0325	0.35477 0.0001	0.36429 0.0001
MEAN	0.35172 0.0001	0.05869 0.4847	0.37533 0.0001	0.39878 0.0001	-0.02911 0.7290	0.43228 0.0001	0.24799 0.0027	0.36234 0.0001	1.00000 0.0	0.54867 0.0001	0.98269 0.0001	0.99234 0.0001
STDD_DEV	0.21766 0.0088	0.07817 0.3517	0.22327 0.0071	0.21968 0.0082	0.07380 0.3794	0.15185 0.0692	0.15942 0.0563	0.17831 0.0325	0.54867 0.0001	1.00000 0.0	0.46392 0.0001	0.56276 0.0001
V15THPER	0.32135 0.0001	0.03943 0.6389	0.35631 0.0001	0.38518 0.0001	-0.03140 0.7087	0.43034 0.0001	0.24457 0.0031	0.35477 0.0001	0.98269 0.0001	0.46392 0.0001	1.00000 0.0	0.96296 0.0001
V85THPER	0.37659 0.0001	0.07189 0.3918	0.39217 0.0001	0.41240 0.0001	-0.02328 0.7818	0.44172 0.0001	0.25911 0.0017	0.36429 0.0001	0.99234 0.0001	0.56276 0.0001	0.96296 0.0001	1.00000 0.0

APPENDIX-E

APPENDIX E1

Coding Manual for Violation Study

Field No	Code	Description	Categories of the variables
1	obs	Observation No	
2	name	Code of Intersection	
3	approach	Direction of Approach	1- North bound, 2- West bound 3- South bound, 3- East bound
4	time	Time of the day	1- Off-peak, 2- Peak, 3- Evening
5	area	Area of study	1- CBD, 2- Fringe
6	location	Location of Eastern Province	1- Augrabia, 2- Khobar, 3- Thouqba, 4- Dammam, 5- Qatif
7	land_use	Landuse type	1- Residential 2- Commercial
8	ap_width	Approach width (m)	Continuous Variable
9	md_width	Median width (m)	Continuous Variable
10	md_exist	Median exist	0- Not Exist, 1- Exist
11	exlft_ln	Exclusive left lane	0- Not Exist, 1- Exist one lane, 2- Exist two lane
12	exrdt_ln	Exclusive right lane	0- Not Exist, 1- Exist
13	ln_mark	Lane marking	0- Not Exist, 1- Exist
14	noof_ln	Total number of lanes	1- One lane, 2- Two lanes, 3- Three lanes, 4- Four lanes, 5- Five lanes, 7- Seven lanes
15	thru_ln	Total number of thru lane	1- One lane, 2- Two lanes, 3- Three lanes, 4- Four lanes, 6- Six lanes
16	ped_crss	Pedestrian crossing	0- Not Exist, 1- Exist
17	str_type	street type	1- Arterial, 2- Collector, 3- Local
18	sight	Sight distance	1- Good, 2- Bad
19	ped_act	Pedestrian activity	1- Alomost none, 2- Light, 3- Heavy
20	ttime	Yellow signal time	Continuous Variable
21	rtime	Red signal time	Continuous Variable
22	gtime	Green signal time	Continuous Variable
23	cyctime	Cycle length of signal	Continuous Variable
24	vol_lft	Left turning volume	Continuous Variable
25	vol_st	Straight (thru) volume	Continuous Variable
26	vol_rgt	Right turning volume	Continuous Variable

Field No	Code	Description	Categories of the variables
27	vol_tot	Total volume	Continuous Variable
28	hvol_lft	Hourly left turning volume	Continuous Variable
29	hvol_st	Hourly straight (thru) volume	Continuous Variable
30	hvol_rgt	Hourly right turning volume	Continuous Variable
31	hvol_tot	Hourly total volume	Continuous Variable
32	freech	free choice	Continuous Variable
33	nsy	Not stop on yellow	Continuous Variable
34	nsr	Not stop on red	Continuous Variable
35	nsr5sec	Not stop on red after red had been on more than 5 sec	Continuous Variable
36	sor	Starting on red	Continuous Variable
37	rorws	Right turn on red with stop	Continuous Variable
38	rorwos	Right turn on red without stop	Continuous Variable
39	hfreech	Hourly free choice	Continuous Variable
40	hnsy	Hourly not stop on yellow	Continuous Variable
41	hnsr	Hourly not stop on red	Continuous Variable
42	hnsr5sec	Hourly not stop on red after red had been on more than 5 sec	Continuous Variable
43	hsor	Hourly starting on red	Continuous Variable
44	hrorws	Hourly right turn on red with stop	Continuous Variable
45	hrorwos	Hourly right turn on red without stop	Continuous Variable
46	mean	Mean of speed	Continuous Variable
47	stdd_dev	Standard deviation of speed	Continuous Variable
48	v15thper	15th percentile of speed	Continuous Variable
49	v85thper	85th percentile of speed	Continuous Variable

APPENDIX E2

Coding Manual for Violator Study

Field no	Code	Description	Categories of variables
1	Key	Questionnaire number	
2	VT	Violation type	1- Red violation, 2- Speed violation, 3- Control group
3	A1	Learn to drive at a driving school	0- No, 1-Yes
4	A2	How many years have you been driving	Continuous Variable
5	A3	How many Kilometers do you drive in a year.	1- Less than 15,000 Km, 2- 15,000 to 25,000 Km, 3- 25,000 to 50,000 Km, 4- More than 50,000 Km
6	A4	What vehicle do you normally drive	1- Car, 2- Van, 3- Bus, 4-Truck, 5- Other
7	A5	Who owns the Vehicle	1- Myself, 2- Family, 3- Company, 4- Other
8	A6	How long have you been living in this region	Continuous Variable
9	A7	drive the vehicle regularly	0- No, 1-Yes
10	A8	Do you have a temporary driving license	0- No, 1-Yes
11	A9	Do you have a permanent driving license	0- No, 1-Yes
12	A10	Road accidents in last 2 Years	Continuous Variable
13	A11	Road accidents in total driving experience	Continuous Variable
14	A12	Cited for mototring offense	Continuous Variable
15	A13	Fastest speed on cleaar highway	1- 60 Kph, 2- 90 Kph, 3-120 Kph, 4- 150 Kph, 5- 180 Kph
16	A14	Car length you leave	1- Less than 2, 2-2 to 3, 3- 4 to5, 4- 6 or more
17	A15	Legal speed limit on urban street	Continuous Variable
18	A16	Legal speed limit on expressway	Continuous Variable
19	B1	One should always obey traffic laws.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- Disagree, 5- Strongly disagree
20	B2	There are too many unnecessary traffic signs and signals.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- Disagree, 5- Strongly disagree
21	B3	One should avoid taking risks on the roads.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree

22	B4	I would rather accelerate than brake to get out of a difficult situation.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
23	B5	It is useless to check brakes, tires and brake lights on a regular basis.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
24	B6	There should be more traffic enforcement.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
25	B7	I like competing with other vehicles on roads.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
26	B8	I feel a bit anxious when I approach an intersection.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- Disagree, 5- Strongly disagree
27	B9	I like driving fast.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- Disagree, 5- Strongly disagree
28	B10	I don't feel safe when I drive on roads.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
29	B11	There is never any point in taking a chance.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
30	B12	In general, vehicles are well maintained in this area.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
31	B13	I wouldn't mind breaking a traffic law if it means getting out of a difficult situation.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
32	B14	It is sometimes a challenge to overtake the car in front of you.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- disagree, 5- strongly disagree
33	B15	Drivers in Saudi Arabia obey traffic rules in general.	1- Strongly Agree, 2- Agree, 3- Neither agree nor disagree, 4- Disagree, 5- Strongly disagree
159	E1	Nationality	1- Saudi, 2- Other Gulf Countries, 3- Pakistani/Indian, 4- Arabs, 5- Filipino, 6- American/European, 91-

			Bangladesh, 92- Srilanka, 93- Turkey
160	E2	Education	1- No Formal Education, 2- Elementary level, 3-Intermediate Level, 4- High school, 5- University Degree, 9- Other
161	E3	Occupation	1- Salesman, 2- Teacher/Professor, 3- Professional/Managerial, 4- Craftsman/Mechanic/Factory worker, 5- Clerical/Secretarial/Officeworker, 6- Student, 7-Retired, 9- Other
162	E4	Age	1- Less than 18, 2- 18-24 years, 3- 25-30 years, 4- 31-39 years, 5- 40-49 years, 6- 50-59 years, 7-Over 60 years.
163	E5	Monthly income	1- Less than 2500Sr, 2- 2500 to 5000 Sr, 3- 5000 to 10,000 Sr, 4- 10,000 to 20,000 Sr, 5-Greater than 20,000 Sr.
164	E6	Marital status	1- Single, 2- Married, 3- Widowed, 4- Divorced
165	E7	Children	Continous Variable

APPENDIX-F

vs3.lst Mon Apr 14 14:08:15 1997 1

VIOLATION TYPE

VT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
RED VIOLATION	79	35.6	79	35.6
SPEED VIOLATION	63	28.4	142	64.0
CONTROL TYPE	80	36.0	222	100.0

DRIVING LEARN AT DRIVING SCHOOL

A1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NOT LEARN AT SCH	96	43.2	96	43.2
LEARN AT SCHOOL	126	56.8	222	100.0

DRIVING EXPERIENCE

AA2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
INEXPERIENCED	15	6.8	15	6.8
EXPERIENCED	207	93.2	222	100.0

KM DRIVEN IN A YEAR

A3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
LESS TH 15000	58	26.1	58	26.1
15000 to 25000	53	23.9	111	50.0
25000 to 50000	48	21.6	159	71.6
MORE TH 50000	63	28.4	222	100.0

TYPE OF VEHICLE

A4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CAR	186	83.8	186	83.8
VAN	24	10.8	210	94.6
BUS	2	0.9	212	95.5
Truck	9	4.1	221	99.5
OTHER	1	0.5	222	100.0

OWNER OF THE VEHICLE

A5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
MYSELF	136	61.3	136	61.3
FAMILY	23	10.4	159	71.6
COMPANY	57	25.7	216	97.3
OTHER	6	2.7	222	100.0

HOW LONG LIVING IN THE REGION

AA6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
LESS FAMILIAR	21	9.5	21	9.5
FAMILIAR	201	90.5	222	100.0

DRIVE VEHICLE REGULARLY

A7	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NOT DRIVE REG.	7	3.2	7	3.2
DRIVE REGULARLY	215	96.8	222	100.0

TEMPORARY DRIVING LICENSE

AA8	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NO	216	97.3	216	97.3
YES	6	2.7	222	100.0

PERMANENT DRIVING LICENSE

AA9	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NO	12	5.4	12	5.4
YES	210	94.6	222	100.0

ROAD ACCIDENT IN LAST 2 YEARS

A10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	158	71.2	158	71.2
1	47	21.2	205	92.3
2	15	6.8	220	99.1
3	2	0.9	222	100.0

ROAD ACCIDENT IN TOTAL DRIVING EXP.

A11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	108	48.6	108	48.6
1	70	31.5	178	80.2
2	24	10.8	202	91.0
3	17	7.7	219	98.6
4	1	0.5	220	99.1
5	1	0.5	221	99.5
6	1	0.5	222	100.0

MOTORING OFFENSE IN LAST 2 YEARS

A12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	119	53.6	119	53.6
1	39	17.6	158	71.2
2	24	10.8	182	82.0
3	20	9.0	202	91.0
4	9	4.1	211	95.0
5	4	1.8	215	96.8
6	1	0.5	216	97.3
10	4	1.8	220	99.1
11	1	0.5	221	99.5
15	1	0.5	222	100.0

FASTEST SPEED ON HIGHWAY

A13	Frequency	Percent	Cumulative Frequency	Cumulative Percent
60 Kph	6	2.7	6	2.7
90 Kph	35	15.8	41	18.5
120 Kph	118	53.2	159	71.6
150 Kph	57	25.7	216	97.3
180Kph OR MORE	6	2.7	222	100.0

DISTANCE FROM OTHER CAR

A14	Frequency	Percent	Cumulative Frequency	Cumulative Percent
LESS THAN 2	55	24.8	55	24.8
2 to 3	95	42.8	150	67.6
4 to 5	47	21.2	197	88.7
6 OR MORE	25	11.3	222	100.0

LEGAL SPEED ON URBAN STREET

A15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
10	1	0.5	1	0.5
15	1	0.5	2	0.9
20	6	2.7	8	3.6
30	11	5.0	19	8.6
40	51	23.0	70	31.5
45	2	0.9	72	32.4
50	18	8.1	90	40.5
60	81	36.5	171	77.0
65	1	0.5	172	77.5
70	10	4.5	182	82.0
80	36	16.2	218	98.2
90	1	0.5	219	98.6
100	3	1.4	222	100.0

LEGAL SPEED ON EXPRESSWAY

A16	Frequency	Percent	Cumulative Frequency	Cumulative Percent
60	1	0.5	1	0.5
80	8	3.6	9	4.1
90	2	0.9	11	5.0
100	16	7.2	27	12.2
110	4	1.8	31	14.0
120	177	79.7	208	93.7
130	3	1.4	211	95.0
140	6	2.7	217	97.7
150	4	1.8	221	99.5
160	1	0.5	222	100.0

NATIONALITY

E1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
SAUDI	140	63.1	140	63.1
GULF	1	0.5	141	63.5
PAKISTANI/INDIAN	45	20.3	186	83.8
ARABS	18	8.1	204	91.9
FILIPINO	10	4.5	214	96.4
AMERICAN/EUROPEA	2	0.9	216	97.3
BANGLADESH	3	1.4	219	98.6
SRILANKA	1	0.5	220	99.1
TURKEY	2	0.9	222	100.0

EDUCATION

E2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
NO FORMAL EDUCAT	5	2.3	5	2.3
ELEMENTRY LEVEL	30	13.5	35	15.8
INTERMEDIATE LEV	42	18.9	77	34.7
HIGH SCHOOL	70	31.5	147	66.2
UNIVERSITY DEGRE	73	32.9	220	99.1
OTHER	2	0.9	222	100.0

OCCUPATION

E3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
SALESMAN	9	4.1	9	4.1
TEACH/PROFESS	3	1.4	12	5.4
PROFESION/MANAGE	41	18.5	53	23.9
CRAFTS/MECHANIC	22	9.9	75	33.8
CLERICAL/SECRETA	28	12.6	103	46.4
STUDENT	36	16.2	139	62.6
RETIRED	2	0.9	141	63.5
OTHER	51	23.0	192	86.5
DRIVER	30	13.5	222	100.0

AGE (YEARS)

E4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
LESS THAN 18	2	0.9	2	0.9
18-24	55	24.8	57	25.7
25-30	65	29.3	122	55.0
31-39	61	27.5	183	82.4
40-49	29	13.1	212	95.5
50-59	10	4.5	222	100.0

MONTHLY INCOME (SR)

E5	Frequency	Percent	Cumulative Frequency	Cumulative Percent
LESS TH. 2500	96	43.2	96	43.2
2500 to 5000	69	31.1	165	74.3
5000 to 10000	34	15.3	199	89.6
10000 to 20000	18	8.1	217	97.7
GREAT TH 20000	5	2.3	222	100.0

MARITAL STATUS

E6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
SINGLE	83	37.4	83	37.4
MARRIED	137	61.7	220	99.1
DIVORCED	2	0.9	222	100.0

NUMBER OF CHILDREN

E7	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	106	47.7	106	47.7
1	23	10.4	129	58.1
2	35	15.8	164	73.9
3	18	8.1	182	82.0
4	10	4.5	192	86.5
5	11	5.0	203	91.4
6	10	4.5	213	95.9
7	4	1.8	217	97.7
8	1	0.5	218	98.2
9	1	0.5	219	98.6
11	1	0.5	220	99.1
12	1	0.5	221	99.5
14	1	0.5	222	100.0

APPENDIX-G

Rotated Factor Pattern

	FACTOR1	FACTOR2	
Q1	-0.13722	0.52230	Always obey traffic laws
Q2	0.49391	-0.14070	too many traffic signs
Q3	-0.22076	0.60508	Avoid taking risk
Q4	0.63654	0.07695	rather accelerate than brake
Q5	0.55764	-0.04931	Useless to check brake and tires
Q6	-0.24810	0.38711	more traffic enforcement
Q7	0.68149	0.02436	like competing with other vehicles
Q8	0.10643	0.54790	Feel anxious when approach at X
Q9	0.66503	0.01885	I like driving fast
Q10	0.10145	0.46626	I dont feel safe on roads
Q11	-0.12708	0.4904[illegible]	Never any point in taking a chance
Q12	-0.04955	-0.3172[illegible]	Veh are well maintained in this area
Q13	0.44420	0.2276[illegible]	I wouldnt mind breaking a traffic law
Q14	0.22607	0.45757	Challange to overtake the car
Q15	-0.12721	-0.29991	Driver in S.A. obey traffic rules

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	
Q1	-0.06130	0.48595	0.23400	Always obey traffic laws
Q2	0.37638	-0.40243	0.25449	too many traffic signs
Q3	-0.11505	0.60934	0.21357	Avoid taking risk
Q4	0.56589	-0.19219	0.29990	rather accelerate than brake
Q5	0.44488	-0.34843	0.32453	Useless to check brake and tires
Q6	-0.32962	0.09530	0.60293	more traffic enforcement
Q7	0.74511	0.04356	-0.15975	like competing with other vehicles
Q8	0.24477	0.59414	0.06746	Feel anxious when approach at X
Q9	0.71942	0.02360	-0.13620	I like driving fast
Q10	0.11890	0.29503	0.37317	I dont feel safe on roads
Q11	0.01618	0.60602	-0.00659	Never any point in taking a chance
Q12	-0.03017	-0.13862	-0.35170	Veh are well maintained in this area
Q13	0.49070	0.16333	0.07317	I wouldnt mind breaking a traffic law
Q14	0.23416	0.25155	0.39793	Challange to overtake the car
Q15	-0.01311	0.08070	-0.63583	Driver in S.A. obey traffic rules

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	
Q1	-0.01326	0.47878	0.18022	-0.25920	Always obey traffic laws
Q2	0.26535	-0.48721	0.08710	-0.23056	too many traffic signs
Q3	-0.04305	0.61261	0.18841	-0.24636	Avoid taking risk
Q4	0.47744	-0.31696	0.18887	-0.30114	rather accelerate than brake
Q5	0.26476	-0.54131	0.33280	-0.13186	Useless to check brake and tires
Q6	-0.45377	0.01480	0.39616	-0.37244	more traffic enforcement
Q7	0.75412	-0.07017	0.07158	0.08205	like competing with other vehicles
Q8	0.19487	0.36926	0.57065	0.20410	Feel anxious when approach at X
Q9	0.78719	0.00108	-0.11743	-0.10633	I like driving fast
Q10	-0.06512	0.00296	0.74874	0.08084	I dont feel safe on roads
Q11	0.11877	0.61001	0.10945	-0.06263	Never any point in taking a chance
Q12	-0.08443	-0.21796	0.06557	0.55870	Veh are well maintained in this area
Q13	0.45397	0.02001	0.26266	-0.02020	I wouldnt mind breaking a traffic law
Q14	0.12227	0.05576	0.51823	-0.17431	Challange to overtake the car
Q15	0.01829	0.03645	-0.03489	0.77222	Driver in S.A. obey traffic rules

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	
Q1	-0.01492	-0.12717	0.53542	0.17457	-0.07659	Always obey traffic laws
Q2	0.01835	0.71209	-0.01967	-0.05539	0.12782	too many traffic signs
Q3	-0.09803	-0.18794	0.64053	0.21941	-0.04162	Avoid taking risk
Q4	0.60309	0.37601	-0.02695	0.00392	-0.01961	rather accelerate than brake
Q5	0.17734	0.65749	-0.17537	0.17125	-0.00114	Useless to check brake and tires
Q6	0.01939	-0.00309	0.13262	0.17061	-0.71819	more traffic enforcement
Q7	0.35342	0.32592	0.07004	0.14828	0.61115	like competing with other vehicles
Q8	0.03793	-0.06821	0.22811	0.69046	0.16214	Feel anxious when approach at X
Q9	0.63275	0.12640	0.11690	-0.10557	0.47198	I like driving fast
Q10	0.11892	0.07805	-0.04927	0.69035	-0.29396	I dont feel safe on roads
Q11	0.11752	-0.36875	0.45718	0.[illegible]0391	0.08268	Never any point in taking a chance
Q12	0.00254	-0.21897	-0.60060	0.18936	0.045[illegible]	Veh are well maintained in this area
Q13	0.78125	-0.16737	-0.10868	0.20514	-0.040[illegible]	I wouldnt mind breaking a traffic law
Q14	-0.02162	0.35995	0.30233	0.45071	-0.02615	Challange to overtake the car
Q15	-0.34926	-0.21950	-0.39575	0.28100	0.49012	Driver in S.A. obey traffic rules

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	
Q1	0.09826	0.78044	-0.14231	-0.02240	-0.00522	0.05138	Always obey traffic laws
Q2	0.74690	-0.04729	0.13055	-0.08929	-0.04535	-0.05598	too many traffic signs
Q3	-0.09916	0.70479	-0.06134	-0.10811	0.15270	-0.13701	Avoid taking risk
Q4	0.52050	0.05037	0.01020	0.54615	-0.05852	-0.02289	rather accelerate than brake
Q5	0.69495	-0.16253	-0.00291	0.11014	0.11552	0.04423	Useless to check brake and tires
Q6	0.06588	0.19261	-0.72862	0.06644	0.10412	-0.08353	more traffic enforcement
Q7	0.32005	0.01006	0.64915	0.26419	0.20051	-0.03176	like competing with other vehicles
Q8	-0.13670	0.19282	0.15941	0.05673	0.72977	0.01639	Feel anxious when approach at X
Q9	0.23444	0.14244	0.52264	0.55696	-0.12479	-0.05770	I like driving fast
Q10	0.08552	0.02504	-0.32293	0.17206	0.63434	0.13987	I dont feel safe on roads
Q11	-0.26708	0.56405	0.06800	0.13547	0.17270	-0.02294	Never any point in taking a chance
Q12	0.06180	-0.05426	-0.12912	0.10331	-0.11260	0.51864	Ven are well maintained in this area
Q13	-0.12605	-0.10028	0.02380	0.61364	0.20411	-0.01584	I wouldnt mind breaking a traffic law
Q14	0.21308	0.06956	0.02931	-0.07234	0.39331	-0.29361	Challange to overtake the car
Q15	-0.10956	-0.04032	0.33608	-0.28692	0.10747	0.68725	Driver in S.A. obey traffic rules

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6	FACTOR7
Q1	0.04339	0.00324	0.81737	0.09401	-0.00656	0.02686	0.00674
Q2	0.77872	-0.06838	-0.06815	-0.05555	0.05937	-0.00532	-0.16050
Q3	-0.16099	-0.09719	0.74966	-0.01541	0.13289	-0.16006	0.09078
Q4	0.52322	0.55081	0.04207	-0.00270	-0.06461	-0.03731	-0.00090
Q5	0.67216	0.08158	-0.07550	-0.09554	0.00964	0.00476	0.30266
Q6	0.09149	0.09148	0.14488	0.79278	0.12057	-0.07490	0.04126
Q7	0.30208	0.26442	0.01365	-0.67193	0.19814	-0.01539	0.04193
Q8	-0.14000	0.08809	0.14120	-0.12306	0.70166	0.07025	0.24662
Q9	0.23063	0.57106	0.10595	-0.49828	-0.03911	-0.04649	-0.18824
Q10	0.00928	0.12073	0.16230	0.11782	0.27722	0.04095	0.78454
Q11	-0.20945	0.23767	0.36340	0.17362	0.43975	0.10502	-0.46238
Q12	0.05536	0.11472	-0.02937	0.12572	-0.24463	0.78368	0.11726
Q13	-0.12162	0.80871	-0.14826	-0.02057	0.13546	-0.03641	0.15269
Q14	0.25558	-0.02784	-0.02792	0.09311	0.70334	-0.19379	0.02263
Q15	-0.08194	-0.23644	-0.09956	-0.22396	0.16532	0.75537	-0.11233

V i t a

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