Influencing Factors Behind Car Accidents and Traffic Violation in Saudi Arabia

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Abstract— **This Paper purpose is to highlight the effect of factors that have affected the number of cars accidents in Jeddah, Saudi Arabia. Influencing factors have been considered using the opinions of traffic accidents experts during a brainstorming meeting. The factors are to be assessed to know their significant effect on the number of car accidents. Multiple Regression Analysis is performed, the first Multiple Regression Analysis aimed to filter the significant variables. The second Regression Analysis is performed to develop an LP model that forecasts the number of cars accidents based on factors scores.**

Keywords—**Mulipule Regression Analysis; ANOVA; Hypothesis Testing; Traffic Accident, KSA.**

I. INTRODUCTION

Car Accidents are a very critical aspect in our modern life and Governments aims to minimize the total number of car accidents. However, it is important to know the traffic hazards that are causing car accidents in Jeddah, Saudi Arabia and recommend some mitigation measures for it.

According to a study, those among the influencing factors behind auto collisions are natural conditions (Climate, Illumination, and so forth), street qualities, vehicle plan, human blindness, and vehicles traffic on the street [1].

Delays in clearing traffic accidents due to delays in investigations are observed by streets users in Saudi Arabia. This project shall provide some practical solutions to control the number of roads accidents.

Stated by [2], that the Traffic accidents happen when you are traveling on the road vehicle. Traffic accidents are divided into 3 types:

1. Minor accidents involving vehicles or goods.
2. Moderate damage and accidents cause slight damage with minor injuries and damage to vehicles or goods.
3. Serious accidents resulting in death or serious injury.

A study highlighted that reconstruction of traffic accidents management is an evolution discipline, with techniques, knowledge and tools. The assessment of traffic accidents are mainly to highlight the indirect causes [3].

Accident investigation is an essential process. Many strategies and Many techniques have been used for the improvement of vehicles incident investigation process [4].

A study has highlighted the elements contributing to the severity of rear-end collisions, these factors include the number of participating vehicles and trucks attendance, weather conditions, and poor lighting conditions [5]. In traffic accidents, many Investigation techniques were applied to determine the cause of the accident.

Some studies identify these causes through the analysis of large amount of data regarding the direction of movement, speed, everything unusual movement of all vehicles involved, skid marks, changes in direction, debris shape, curve start or end, signs of warming, grooves, scratches, intersections and any detail to be measured [6].

II. STUDY TOOLS

A. Fishbone Diagram

The Fishbone shows a system for investigating the causes of a Problem [7]. These causes are most generally portrayed as the fishbone diagram. The name fishbone is given to resembles a fish skeleton. However, according to [8], the fishbone diagram is used to:

1. Demonstrate the relation between the causes and the problem.
2. Demonstrate all influencing factor.
3. Enable conceptualizing.
4. Assist in keeping up similar causes under the same category.

The diagram points out the challenges while investigating the problem. The categories that are set for the fishbone diagram are:

1. Man: this represents the human characteristics.
2. Machinery: this represents the characteristics of equipment used.
3. Materials: Materials characteristics which are involved in the process.
4. Method: the procedures involved in the process.
5. Environment: The characteristics of the surroundings.
6. Measurement: the methodologies associated with the assortment, estimations and show of information.

Afterwards, an evaluation of the issues is completed to determine the influencers.

B. Multiple Linear Regression Analysis

Given that data is available for multiple factors a multiple regression model could be performed between the response and the factors. Since data could be categorical variable, it is needed to understand the numerical coding, say, Not affecting at all = 1 to Strong Effect = 5. For this case, when the multiple regression is conducted, the regression forecast in the model for variable status will be for the categorical comparison.

$$y_j = a + b_1x_1 + b_2x_2 + b_3x_3 + \cdots .. b_ix_i + E \ldots \ldots \ldots . (1)$$

Where, $y_j: Response\ at\ point\ j. were\ j = 1 \ldots . N$

$$a: constant$$
$$b_i: Slope\ at\ point\ i = 1 \ldots \ldots N$$
$$x_i: Independent\ Variable\ i = 1 \ldots . N$$
$$E: Error$$

III. METHODOLOGY

This section shows this paper steps for analyzing the effect of each of the main factors on the number of car accidents in Jeddah, Saudi Arabia.

A brainstorming session with some experts from the traffic department in Saudi Arabia has been made on the causes of car accidents. For illustration purpose, a fishbone diagram for the experts opinions is drawn in figure 1 for the root causes of car accidents.
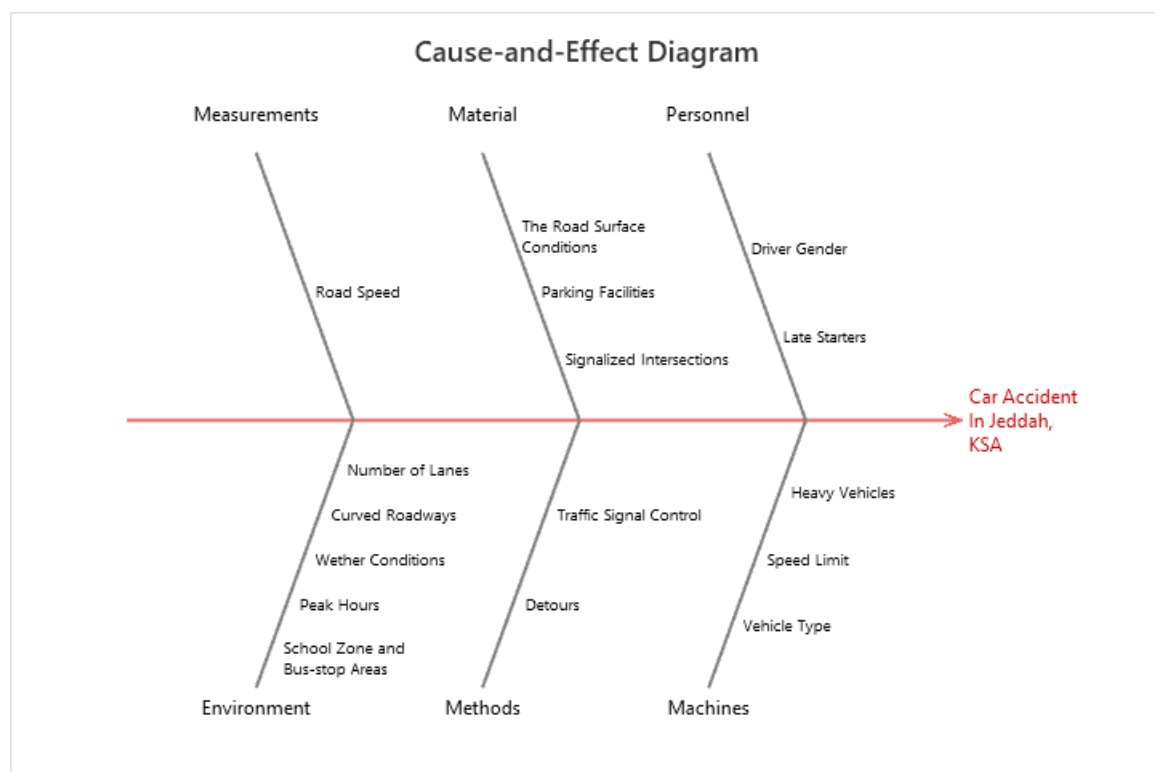

Fig 1. Fishbone Diagram for Factors Affecting Cars Accidents in Jeddah, Saudi Arabia

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

The questions which shall be asked to the questionnaire participants are about the influence of each of the brainstormed factors discussed below:

Q1- What is the effect of the roadway width on the number of car accidents (Variable x1)?

This question asks the participants about their opinions regarding the effect of the width of the road on the number of car accidents.

Q2- What is the effect of the vehicle type on the number of car accidents (Variable x2)?

This question asks the participants about the effect of the vehicle type. This includes the effect of the car maker, the model year, vehicle size and use (i.e. medical) on the number of cars accidents.

Q3- What is the effect of the detours on the number of car accidents (Variable x3)?

This question asks the participants about their opinion about the effect of temporary detours arranged by the municipalities of Jeddah on the number of car accidents.

Q4- What is the effect of the speed limit on the number of car accidents (Variable x4)?

This question asks the participants about their opinions about the effect of the speed limits set by the municipalities of Jeddah on the number of car accidents.

Q5- What is the Effect of the signalized intersection on the number of car accidents (Variable x5)?

This question asks the participants about their opinion about the effect of the signalized intersection (points at which vehicles change their direction) on the number of cars accidents.

Q6- What is the effect of the number of lanes on the number of car accidents (Variable x6)?

This question asks the participants about their opinion about the effect of the number of lanes arranged by the municipalities of Jeddah and the number of car accidents.

Q7- What is your evaluation regarding the effect of traffic peak hours on the number of cars accidents (Variable x7)?

This question asks the participant about the temporary detours arranged by the municipalities of Jeddah and the number of car accidents.

Q8- What is the effect of the traffic signal control on the number of car accidents (Variable x8)?

This question asks the participants about their opinion about the effect of the traffic signals arranged by the municipalities of Jeddah on the number of car accidents.

Q9- What is the effect of the curved roadways on the number of cars accidents (Variable x9)?

This question asks the participants about their opinions about the effect of the curved roadways (With angle) on the number the number of car accidents.

Q10- What is the effect of the inclement weather on the number of car accident accidents (Variable x10)?

This question asks the participants about their opinions about the effect of the weather conditions on the number of car accidents.

Q11- What is the effect of driver gender on the number of car accidents (Variable x11)?

This question asks the participants about the effect of the driver gender on the number of car accidents.

Q12- What is the effect of the late starters on the number of car accidents (Variable x12)?

This question asks the participants about their opinion about the effect of late starts and the number of car accidents.

Q13- What is the effect of the road surface on the number of car accidents (Variable x13)?

This question asks the participants about their opinion about the road surface condition on the number of car accidents.

Q14- What is the effect of the parking facilities on the number of car accidents (Variable x14)?

This question asks the participants about their opinion about the effect of the availability of parking facilities on the number of car accidents.

Q15- What is the effect of the heavy vehicle on the number of car accidents (Variable x15)?

This question asks the participants about their opinion about the effect of the heavy vehicles on the number of car accidents.

Q16- What is the effect of the school zone and bus-stop area on the number of car accidents (Variable x16)?

This question asks the participant about their opinion about the school zone and bus-stops effects on the number of car accidents.

Q17- What are the number of car accidents that you have been involved (Response y)?

This question answer reflects the number of car accidents they have been involved in.

A. Data Collection

An online survey was conducted for the assessment of the factors affecting the number of cars accidents in Jeddah, Saudi Arabia. Table 1 below shows the respondents demographical data.

Table 1: 83 Respondents Demographical Data

Categories	Count
Age Category	
Above 18 and less than 30	16
Above 30 and less than 40	56
Above 40 and less than 50	10
Above 50	1
Academic Qualification	
High School	5
Bachelor	60
Master	17
PhD	1
Other	0
Job Title	
Officer	22
Head of the Department	40
Director of the Department	11
Senior Management	1
Others	9
Job Experience	
Less than 5 years	15
6-10	39
11-15	13
More than 15 years	16
Company Size	
Less than 5 employees	2
5-50	19
51-200	7
201 or more	55
Monthly Salary	
5000-10000	18
10001-15000	24
15001-20000	8
More than 20001	33

B. Questionaire Responses

Table 2 below shows the 83 responses collected for drivers in Jeddah, KSA.

Since the data are categorical variable, it is needed to understand that the numerical coding is as follows:

- Strong Effect=5
- Normal Effect=4
- Neutral=3
- No Effect=2
- Strongly no Effect=1

Table 2: Responses of 83 Drivers in Jeddah, KSA

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17
1	2	2	2	5	5	4	5	5	5	4	5	5	5	4	5	5	2
2	5	5	4	3	5	5	2	3	4	5	4	5	5	2	4	1	1
3	5	2	3	5	5	5	5	5	5	5	4	3	3	5	5	5	2
4	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	4
5	4	3	4	5	4	4	4	4	4	4	4	5	3	4	4	4	3
6	4	3	4	3	4	4	5	3	4	5	4	5	5	4	4	4	2
7	2	1	3	4	4	4	5	5	3	2	1	2	4	3	3	1	1
8	5	2	3	5	5	5	4	5	5	5	5	5	5	2	5	4	1
9	2	2	3	4	4	2	5	1	5	4	5	4	5	4	4	4	2
10	5	4	4	3	3	3	4	4	4	4	2	2	4	4	3	3	3
11	1	1	1	1	1	1	1	1	1	1	1	1	1	2	5	5	1
12	4	3	4	5	4	4	4	4	4	4	4	5	3	4	3	4	3
13	2	2	2	5	5	4	5	5	5	4	5	5	5	4	5	5	2
14	2	2	2	5	5	4	5	5	5	4	5	5	5	4	5	5	2
15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
16	5	2	4	5	5	5	5	5	5	5	5	5	5	5	5	5	3
17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	3	3	3	3	4	3	2	4	5	4	3	4	4	2	4	3	3
19	5	4	3	5	2	2	2	3	2	5	3	5	3	1	1	1	1
20	5	2	2	5	5	3	4	3	3	5	5	5	4	1	3	1	1
21	5	3	5	5	3	5	5	3	3	3	5	4	5	2	4	3	4
22	4	3	5	5	5	5	4	5	5	5	4	3	4	5	4	5	3
23	5	1	4	5	5	5	5	5	5	5	4	5	5	4	5	5	5
24	5	4	5	5	5	4	5	5	5	4	4	4	5	4	4	4	2
25	3	4	3	4	4	4	5	4	3	4	4	5	5	4	4	1	1
26	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
27	4	3	4	4	3	4	4	2	3	4	4	4	4	3	4	3	4
28	3	3	4	2	2	2	4	4	3	5	4	2	3	3	4	4	3
29	5	3	5	4	4	5	5	5	5	5	4	5	5	5	5	5	4
30	3	4	3	3	3	3	3	3	3	5	5	3	4	3	3	3	3
31	1	2	4	3	4	2	4	3	4	4	4	2	4	3	4	4	2
32	5	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
33	2	2	4	5	5	4	5	4	5	5	4	4	5	3	5	4	1
34	4	3	4	4	4	3	4	5	4	3	3	4	4	4	3	4	2
35	5	4	3	5	5	3	5	5	3	2	2	3	4	4	3	2	2
36	5	4	5	4	5	5	5	5	5	5	5	5	4	5	5	5	3
37	5	4	5	4	5	5	5	5	5	5	5	5	4	5	5	5	3
38	1	1	3	4	4	4	4	4	5	4	2	5	5	2	3	2	1
39	4	3	5	5	5	5	4	5	5	5	4	3	4	5	4	5	3
40	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	1
41	3	4	3	3	3	4	4	4	4	3	4	4	4	3	3	5	1
42	5	4	5	4	5	5	5	5	5	5	5	5	4	5	5	5	3
43	5	4	3	5	5	3	5	5	3	2	2	3	4	4	3	2	2

44	5	1	5	4	4	4	4	5	5	5	5	3	4	4	4	3	1
45	3	3	3	3	4	3	2	4	5	4	3	4	4	2	4	3	3
46	5	3	5	4	4	5	5	5	5	5	4	5	5	5	5	5	4
47	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
48	4	2	4	4	4	5	5	3	2	4	5	5	5	2	3	3	2
49	2	4	2	2	4	2	5	5	5	2	5	4	4	4	4	4	2
50	2	4	2	2	4	2	5	5	5	2	5	4	4	4	4	4	2
51	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
52	5	3	5	4	4	5	5	5	5	5	4	5	5	5	5	5	4
53	2	3	2	4	5	5	5	4	5	4	5	4	4	4	3	4	3
54	4	2	4	4	4	5	5	3	2	4	5	5	5	2	3	3	2
55	3	4	5	5	5	3	5	4	4	5	4	5	5	3	5	4	1
56	2	3	2	4	5	5	5	4	5	4	5	4	4	4	3	4	3
57	2	3	2	4	5	5	5	4	5	4	5	4	4	4	3	4	3
58	2	2	4	2	2	4	2	4	4	4	5	4	4	3	2	2	2
59	3	2	4	5	5	5	4	4	4	5	3	4	5	2	5	5	5
60	1	2	2	3	3	4	5	4	5	5	5	5	4	3	4	4	3
61	2	3	4	4	4	4	5	3	4	5	5	5	5	3	5	5	3
62	3	1	3	3	5	4	4	2	4	4	4	4	3	2	3	4	1
63	3	2	5	5	5	4	3	1	4	5	2	5	4	4	4	4	2
64	2	2	4	4	4	2	4	4	4	4	5	4	4	2	4	4	2
65	4	4	4	4	4	4	5	5	4	4	4	4	4	4	5	5	3
66	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
67	1	2	2	3	3	4	5	4	5	5	5	5	4	3	4	4	3
68	4	4	4	5	5	5	5	5	5	5	5	5	4	4	5	4	3
69	4	5	4	4	3	3	4	2	2	1	4	5	3	2	4	2	2
70	5	2	4	4	3	4	5	5	5	4	3	4	4	1	4	4	2
71	2	3	4	4	4	4	5	3	4	5	5	5	5	3	5	5	3
72	3	2	2	3	2	3	4	3	3	4	4	4	3	4	3	4	2
73	2	3	2	3	3	2	5	3	2	2	5	4	4	2	2	2	2
74	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
75	5	3	4	5	5	5	5	5	5	5	5	5	5	2	5	2	4
76	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
77	4	3	2	4	2	2	3	3	2	4	4	4	4	4	4	4	2
78	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
79	3	4	5	5	5	3	5	4	4	5	4	5	5	3	5	4	1
80	3	2	2	3	2	3	4	3	3	4	4	4	3	4	3	4	2
81	4	3	2	4	2	2	3	3	2	4	4	4	4	4	4	4	2
82	5	4	5	5	5	4	5	5	5	4	4	4	5	4	4	4	2
83	5	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Average	3.4	2.8	3.4	3.8	3.9	3.7	4.1	3.8	3.9	3.9	3.9	4	4	3.3	3.8	3.6	2.4
Standard Deviation	1.4	1.1	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.2	1.2	1.2	1.1	1.2	1.1	1.3	1.1

C. Mulipule Regression Analysis

Regression analysis is used to formulate a linear equation to relate the independent variable to the dependent variables. This paper goal is to assess the factors that have a significant effect on the number of car accidents. The number of car accidents involved by the respondents, while the average score is 2.4. This means that the average number of car accidents are between score 2 and 3 car accident per respondent. The test of hypothesis helps in accepting or rejecting the linear equation. Thus, high p-values are against the rejection of the null hypothesis ($H_o: Accept\ LP$).

Given that data is available for the 16 questioned factors, a multiple regression model could be performed between the number of cars accidents for Respondents in Jeddah, Saudi Arabia and the 16 factors.

Table 3: Multiple Regression Analysis Output to the 16 questioned factors to the number of Cars Accidents

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.64							
R Square	0.41							
Adjusted R Square	0.27							
Standard Error	0.91							
Observations	83							
ANOVA								
	Df	*SS*	*MS*	*F*	*Significance F*			
Regression	16	39.54	2.47	2.93	0.001			
Residual	66	55.60	0.842					
Total	82	95.15						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.21	0.44	0.48	0.62	-0.66	1.09	-0.66	1.09
X 1	0.04	0.11	0.37	0.70	-0.19	0.27	-0.19	0.27
X 2	0.19	0.12	1.49	0.14	-0.06	0.44	-0.06	0.44
X 3	0.01	0.14	0.09	0.92	-0.27	0.30	-0.27	0.3
X 4	0.09	0.18	0.52	0.59	-0.26	0.45	-0.26	0.45
X 5	-0.41	0.19	-2.19	0.03	-0.79	-0.03	-0.79	-0.03
X 6	0.45	0.15	2.95	0.004	0.14	0.76	0.14	0.76
X 7	0.04	0.16	0.25	0.79	-0.29	0.38	-0.29	0.38
X 8	-0.09	0.15	-0.63	0.52	-0.41	0.21	-0.41	0.21
X 9	0.19	0.19	0.98	0.32	-0.19	0.58	-0.19	0.58
X 10	-0.02	0.15	-0.14	0.88	-0.33	0.29	-0.33	0.29
X 11	0.02	0.14	0.15	0.87	-0.26	0.31	-0.26	0.31
X 12	-0.17	0.16	-1.05	0.29	-0.51	0.15	-0.51	0.15
X 13	0.02	0.20	0.13	0.89	-0.37	0.43	-0.37	0.43
X 14	0.004	0.14	0.03	0.97	-0.27	0.28	-0.27	0.28
X 15	0.08	0.17	0.5	0.61	-0.26	0.43	-0.26	0.43
X 16	0.19	0.15	1.23	0.22	-0.11	0.50	-0.11	0.5

IV. DATA ANALYSIS

The results of the Multiple Regression Analysis between these categorical factors and the Number of the car accidents occurring in Jeddah, Saudi Arabia is shown in Table3 and is generated using Microsoft Excel data analysis tools (2010). The Multiple Regression analysis shows that there are two factors that has a p-value < 0.05 and is considered significant factors. Namely, the signalized intersection with a p-value= 0.03 and the number of the road lanes with a p-value=0.004. Afterwards, a multiple regression analysis on the two significant factors is done as per table 4 below.

Table 4: Multiple Regression Analysis Output to Relate the signalized intersection and the number of lanes to the number of cars accidents

SUMMARY OUTPUT

Regression Statistics								
Multiple R	0.54							
R Square	0.30							
Adjusted R Square	0.28							
Standard Error	1.03							
Observations	83							

ANOVA								
	Df	SS	MS	F	Significance F			
Regression	2	36.75	18.37	17.27	5.8E-07			
Residual	80	85.10	1.06					
Total	82	121.8						

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.11	0.39	2.83	0.005	0.33	1.89	0.33	1.89
X 5	0.293	0.13	2.19	0.03	0.027	0.56	0.02	0.56
X 6	0.291	0.13	2.18	0.03	0.025	0.55	0.025	0.55

The analysis shows that constant is significant (p-value= 0.005) and the slope coefficient of variable 1(the signalized intersection(x_5)) p-value=0.03 as well as the slope coefficient of variable 2(number of lanes (x_6))p-value=0.03. This shows that the linear programming model that is significant to estimate the number of cars accidents in Jeddah, Saudi Arabia relays on the categorical score of the signalized intersection and the number of lanes. Equation one represents the Model:

$$y = 1.11 + 0.293x_1 + 0.292x_2 \dots \dots \dots \dots (2)$$

A. Managerial Insights

From the above results, this paper concludes that the average number of car accidents for respondents in Jeddah, Saudi Arabia is high (Participants average number of accidents=2.36) with a standard deviation of 1.07. However, the analysis shows that the average number of cars accidents has been affected by the score of the signalized intersection and the number of lanes. To overcome these issues, it is recommended for the municipalities of Jeddah to mitigate the signalized intersection effect by closing risky intersections and trying to route the drivers in a one way driving roads. Meanwhile, it is also recommended to control the number of cars accidents by trying to remark the lanes and to put cat eyes on the road to maximize the number of lanes. Although, the built equation can describe 54% of the responses, there is still some influencing factors that shall be considered by future research.

V. CONCLUSION

This paper has discussed the factors influencing the number of cars accidents occurred in Jeddah, Saudi Arabia. A questionnaire answered by 83 respondents on the factors affecting the number of cars accidents was analyzed. The categorical score for every factor was ranging from Strong Effect=5 to Strongly No Effect=1.

Two multiple regression analysis was performed, the first multiple regression analysis was made on the all of the 16 factors. While the second multiple regression analysis was conducted on the factors that showed their significance (p-value<0.05) in the first Multiple regression analysis. The second multiple regression analysis has developed an LP equation that can estimate the number of cars accidents based on the following affecting factors; (1) Signalized Intersection (p-value=0.03): the gate by which the driver want to change his current road, (2) Number of Lanes(p-vale=0.03): the road number of marked lanes.

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