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ANALYSIS AND EVALUATION OF TRAFFIC ACCIDENTS FOR PRINCIPLE URBAN STREETS IN ARBIL CITY IN IRAQ

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ABSTRACT: - Traffic accidents are considered one of the most important problems in modern societies. Arbil city in Iraq suffers from this problem; it is considered the second major cause of death.

The main objectives of this study are to analyze and evaluate the causes of traffic accidents by using the statistical analysis technique, and self-observation study. In this study Traffic accident data, Geometric condition data ,and Traffic condition data, related to the Arbil streets network was collected, prepared and analyzed by using the Statistical Package for Social Sciences (SPSS) program. High Accident Locations (HAL) on the street network were identified by using various techniques. Self-observation on all selected streets that had (HAL) was summarized. Different predictive statistical models were developed for the streets in Arbil urban area. The Accident prediction models can be used to predict the probability of an accident at a certain location based on different variables. The statistical analysis of the study concluded that some of the geometric and traffic conditions are much related to traffic accident.

It was concluded from this study that the increasing number of segments in principle urban streets will increase the number of total accidents and the number of property damages. Also, it was found that Pedestrian crossing areas ignored by pedestrians and the drivers do not give priority to pedestrians for crossing the street, due to lack of traffic awareness by drivers and pedestrians. The study recommends that Roads should be designed and constructed according to international standards. Also, it is recommended to improve traffic awareness of road users: drivers, pedestrians, and passengers through organized educational awareness programs.
Keywords: *Traffic Accidents. SPSS, High Accident Locations. Traffic Accident Questionnaire Survey. Vehicle Property Damage. Driver, Pedestrian, Vehicle & road Traffic Elements.*

1- INTRODUCTION

A traffic collision, also known as a traffic accident or crash occurs when a vehicle collides with another vehicle, pedestrian, animal, road barriers , or other stationary obstruction such as a tree or utility pole. Traffic collisions may result in injury, death, vehicle damage and property damage (Garber 2009).

A number of factors contribute to the risk of collision including; driver skill and behavior, vehicle design, road design, and road environment. Motor vehicle collisions lead to death and disability as well as financial costs. Traffic accidents cause many losses especially in human life, property damages and resources.

In Iraq, like other countries, traffic accidents are one of the leading causes of death. The growth of car ownership is a major developing problem, especially in Arbil City. Because Iraq is suffering from the effects of road accidents, it is necessary that an effective plan must be coordinated to protect the country from excessive social, economic, and health losses.

This research will analyze the high accident locations in urban streets in Arbil city to figure out the causes of high accidents. The main objective of the study is to analyze and evaluate the causes of traffic accident by using the statistical analysis technique, and self-observation study.

1.1 Problem Definition

In the last three decades, there has been a considerable growth in the road transport section in developing countries. This in turns has led to a substantial increase in the number of fatalities, injuries and suffering due to road accidents. Road accidents in developing countries are one of the leading causes of death particularly in the economically active group. Due to the seriousness of the problem of road accidents in the Third World, road safety research is necessary in these countries to find practical solutions to the problem.

Arbil City is one of the oldest historical cities in the world, located in the north part of Iraq, centered on a level mound called Arbil Land. Arbil city is one of the important ancient cities of Iraq and it is the main connector between the cities of north Iraq. Also, it is the summer metropolitan for Iraq and was chosen as the capital of tourism for the year 2014. All this made Arbil City of high and increased traffic congestion. Although great efforts were made by the concerned ministries and agencies to reduce the severity and rate of accidents, they are increasing dramatically.

1.2 Previous Researches

Abdulhakim, (1990) in his research study of High Accident Frequency Locations in the City Of Arbil, it was noticed that there were locations with worse accident experience known as: High-Accident Frequency Locations (HAFL). The main objective of the study was identification of (HAFL) in the street network of the city of Arbil and recommendation of proper solutions and remedies for those locations. The collected data did not contain all the information about traffic accidents that are necessary for such studies, but by analyzing it, it gave some important results and findings related to reporting and recording of traffic accidents and inefficiency of their systems. The study also contained some conclusion and necessary recommendations emphasizing the need for further research on the identified locations as (HAFL) especially before and after study.

Jrew, et al., (2007) their study was about Developing of Accident Prediction Models for Arbil Urban Area. The main objective of this study was the development of appropriate forms of predictive statistical models for various locations and using these models to identify hazardous locations in Arbil urban area. It was found that accidents increased with traffic volumes but not in a uniform manner.

Abojaradeh et al., (2013) used Prediction Models to improve Traffic Safety in Greater Amman Area. The main objectives of this study were: to develop traffic accidents regression prediction models in Amman Greater Area. These models relate accident numbers, as a dependent variable, to the possible causes of accidents that are related to driver's behavior, as independent variables. Also, to propose effective countermeasures to reduce the frequency and severity of traffic accidents in Jordan. Accident data were collected from the General Security Directorate and from the Jordan Traffic Institute for the selected areas inside Greater Amman Area in Jordan. These data were analyzed and used in the regression models. Several regression prediction models were formed and the best models were chosen. The intersections and road segments, under this study, were arranged according to the traffic accidents severity. The most dangerous and hazardous streets and intersections were located in the study areas. Proper treatments and improvements are needed to reduce the number and severity of accidents in these areas. Preventive countermeasures were recommended to enhance traffic safety in Jordan specially Amman area.

2. STUDY AREA

Arbil City was chosen for this study. Arbil City is considered the Center of Federal and tourist capital for the North Iraq as shown in Figure 1. Arbil also written as Erbil or Irbil is one of the governorates of Iraq, located in the autonomous Kurdistan Region.

Arbil Governorate covers an area of 15,074 square kilometers (5,820 sq mi) in the north of Iraq, with an estimated population (in 2009) of 1.3 million people, the fourth largest city in Iraq after Baghdad, Basra and Mosul ("Largest Cities in Iraq", 2009).

It is located 80 kilometers (50 miles) east of Mosul in the north of Iraq, and is the capital of the Kurdistan Region of Iraq. The citadel of Arbil is considered the nucleus around which the city expanded. Arbil has the best city planning in the region, where the major streets radiate from the citadel and are intersected by three circular roads parallel to the boundaries of the citadel and to each other at different distances.

3. DATA COLLECTION

The required data for the study was collected in three methods: Traffic accident data, Geometric condition data, and Traffic condition data.

3.1 Traffic Accident Data

Traffic accident data in Arbil city were collected for three years (2010-2012). The main items which are needed in the analysis are not available such as the causes of accidents due to driver behaviors. This lack of information must be reconsidered by concerned authorities. Data were analyzed for three years, number of Injuries, fatalities, property damages, and total accidents of each street were recorded. The average for the three years was found. The high accident location was applied by assuming that at least one Black Spot of severe accident to occur on the major streets. The severity index equation (S.I), according to the manual of traffic safety in Jordan, was used. The equation involves listing each crash occurring at a site under one of three severity classes: fatal (F), personal injury (PI), and property damage only (PDO). Fatal crashes are those that result in at least one death. Crashes that result in injuries, but no deaths, are classified as personal injury. Crashes that result in neither death nor injuries but involve damage to property are classified as property damage only.

$$(S.I) = 3F + I + \frac{1}{3}P.D \qquad (2.1)$$

Where:

S.I=Severity Index

F=Number of fatalities

I=Number of injuries

P.D=Number of property damage

The location considered to be high severing (black spot), when the severity index (S.I) is more than 10 (Garber, 2009).

The equation was modified to be easier for application as follows:

$$(S.I) = 9F + 3I + P.D \qquad (2.2)$$

Therefore, equation (2.2) considers the black spot when the S.I is more than 30.

For this study it is assumed that each street can be considered to be High Accident Location (HAL) when at least has one black spot. In Arbil city there are 30 urban major arterial streets as shown in Figure 2. Therefore, by applying equation (2.2), 20 streets resulted as a high accident location (HAL) out of the 30 main streets as shown in Table 1. This table shows the average of three years for the total accidents, fatalities, injuries, and property damage. The 20 streets that resulted as a high accident location are shown in Figure 3.

The accidents distributed on the black Spot Maps which is usually referred to as an effective means to provide a quick visual check of accident concentration throughout a road network. Each accident (or number of accidents) is identified as a spot mark or a pin. Different spot shapes, sizes, or colors may be applied to indicate different accident types and severities as shown in Figure 2, Figure 3, and Figure 4. This distribution has been done in order to visualize the streets of Arbil city that have (HAL).

3.2 Field Observation of the Geometric Conditions Data

The width of streets and median width were measured by using meter. The number of lanes and the width of streets were measured personally to get the exact width of the street and the median. Through Auto cad program, the lengths of the streets and the numbers of segments were evaluated. Table 2 shows the geometric condition data for the selected 20 streets of high accident locations (HAL).

3.3 Field Observation of Traffic Data

Due to the unavailable traffic data in Arbil Municipality, traffic volume study was conducted for 60 days, from late October to early December 2013 on the selected streets. The study was conducted by five observers using traffic counters and video camera. Volume information was recorded from the video tape after the field study. This survey covered the AM peak periods from 8:00 to 9:00 am for three weekdays from Monday to Wednesday. The number of counted vehicles was divided by the number of hours to determine the peak hour volume (PHV) for each street. Through the American Association of State Highway and Transportation Official (AASHTO) for urban areas, it was found that PHV was about (8-10) % of the average daily traffic (ADT) and 65% directional distribution (AASHTO, 2001). Therefore, the additional data were calculated, Space Mean Speed (SMS), Flow Rate (q), and Density (K).Table 3 shows the calculated traffic data for each street.

More Geometric and Traffic condition data were collected directly from the study area on 22/3/2014 such as: Lane width, Sidewalk width, Number of speed calming (humps or bumps), Number of pedestrian bridges, Number of pedestrian cross walk, Speed limit, %Trucks and Buses crossing streets in the peak hours, Pedestrian volume, and Vehicle kilometers of travel. The data was collected in order to improve the analysis results of the geometric and traffic conditions data. Table 4 and Table 5 shows the additional geometric and traffic conditions data .The vehicle - Km of travel according to HCM (Highway Capacity Manual) is equal to (ADT × L).

Where L is the Length of street in (km).

4. STATISTICAL ANALYSIS OF DATA

The Statistical Package for Social Sciences (SPSS) program (IBM SPSS Statistics 22) was applied for the analysis of the collected data. Stepwise regression was used to determine the effect of all variables on road accident rate. SPSS (Statistical Package for Social Sciences) software was used in forming the Regression Models in this study. SPSS is considered one of the most frequently used program for researchers in many fields such as engineering, science, art, education, and psychology (SPSS 2009).

The method of least squares that leads to the best fitting line of a postulated form to a set of data is used to form Regression Models between the dependent variable Yi, and independent variables Xi. It was calibrated by the method of least squares. This relationship is known as a multiple linear regression model. A relationship between the dependent and the independent variables of the form

$$Y_i = ß_0 + ß_1X_1 + ß_2X_2 + \dots + ß_n X_n$$

Stepwise calibration procedure was used to form the Multiple Linear Regression Model. The selections of explanatory variables follow the following four guidelines to decide which explanatory (independent) variables to include in the linear regression model. The selected independent variable has to follow the following four rules:

1. Must be linearly related to the dependent variable.
2. Must be highly correlated with the dependent variable.
3. Must not be highly correlated between themselves.
4. Must lend themselves to relatively easy projection

The selected regression model has to have maximum 3 to 4 variables in order to have an easy projection and application, and in order to have a lower cost. Also, the selected regression model should have strong coefficient of determination R^2 value (Montgomery 2010).

The coefficient of determination R^2, quantifies the fact that the goodness of fit of a regression line increases with the proportion of the total variation that is explained by the regression line. R^2 ranges from zero when none of the total variation is explained by the regression line to unity when all of the variation is explained by the line. It is denoted as a squared quantity to capture the fact that it is always non negative. The square root of R^2 the Coefficient of determination is called the coefficient of correlation (r or R). Its value can range from -1 to 1. In the case of linear regression the sign of R is the same as the sign of the slope of the regression line. When R is near 1, there is a high positive correlation between x and y. when R is near -1, there is a high negative correlation. If R is around zero, then there is no correlation between x and y (Papacostas 2008, Montgomery 2010).

The dependent Variables are selected as follows:

Y1=the average total accidents for the last three years
Y2= the average number of fatalities for the last three years
Y3=the average number of injuries for the last three years
Y4=the average number of property damages for the last three years

The Independent Variables are as follows:

X1= Peak Hour Volume (PHV) (Veh. /hr)
X2=Average daily traffic (ADT) (Veh. /day)
X3=Street length (km)
X4= Street width (m)
X5= Median width (m)
X6= No. of lanes (for each direction)
X7= No. of segments
X8=Space mean speed (sms) (km/hr)
X9= Density (veh./km/lane)
X10=Severity Index (S.I)
X11=Vehicle –Km of travel
X12=Lane width (m)
X13=Shoulder width (m)
X14=Speed limit (Km/ hr)
X15=Number of speed calming (humps or bumps)
X16=Pedestrian volume (Ped. /hr)
X17=Number of pedestrian bridges
X18=Number of pedestrian cross walk
X19=% Trucks and Buses

5. RESULTS OF STATISTICAL ANALYSIS

5.1 Study Results of Accident Data before Adding the Additional Accident Data

The study results from analyzing the accident data by using the SPSS program, as follows:

Models result for Y1 (number of total accidents)

Model number	Dependent variable	R^2	R^2 (adjusted)	F-Value	Sig.<0.05
1	Y1=8.619+0.476 X10	0.989	0.989	1639.253	0.000
2	Y1= - 3.605+3.403 X7 +0.473 X10	0.994	0.993	1345.622	0.000
3	Y1= 2.158+1.503 X3 +0.471 X10	0.993	0.992	1233.556	0.000

Where;
Y1= Number of total accidents
X3=Street length (km)

X7=Number of segment
X10=Severity Index (S.I)

Models result for Y4 (number of property damages)

Model number	Dependent variable	R^2	R^2 (adjusted)	F-Value	Sig. <0.05
1	Y4=12.704+0.273 X10	0.946	0.943	314.019	0.000
2	Y4= - 2.085+4.117 X7 +0.269 X10	0.965	0.961	236.173	0.000
3	Y4= 4.479+1.913 X3 +0.268 X10	0.965	0.961	232.178	0.000

Where;
Y4= Number of property damages
X3=Street length (km)
X7=Number of segments
X10=Severity Index (S.I)

Models result for the Y2 (number of Fatalities)

Model number	Dependent variable	R^2	R^2 (adjusted)	F-Value	Sig. <0.05
1	Y2= - 0.110+ 0.020X10	0.933	0.929	249.754	0.000
2	Y2=1.037- 0.319X7 +0.020X10	0.954	0.949	178.012	0.000

Where;
Y2= Number of fatalities
X7=Number of segments
X10=Severity Index (S.I)

Models result for the Y3 (number of Injuries)

Model number	Dependent variable	R^2	R^2(adjusted)	F-Value	Sig. <0.05
1	Y3=-3.904+ 0.183X10	0.988	0.988	1530.514	0.000

Where;
Y3= Number of injuries
X10=Severity Index (S.I)

5.2 Study Results of Accident Data after Adding the Additional Accident Data

Models result for the Y1 (number of total accidents) after adding the additional Accident data

Model number	Dependent variable	R^2	R^2(adjusted)	F-Value	Sig.<0.05
1	Y1=4.124+0.475X10	0.974	0.972	662.283	0.000
2	Y1=1.835+7.149X3+8.536X17+ 0.486X10	0.997	0.996	1138.749	0.000

Where;
Y1= Number of total accidents
X3=Street length (km)
X10=Severity Index (S.I)
X17=Number of pedestrian bridges

Models result for the Y4 (number of property damages) after adding the additional Accident data

Model number	Dependent variable	R^2	R^2(adjusted)	F-Value	Sig. <0.05
1	Y4=16.649+0.267X10	0.947	0.944	323.164	0.000
2	Y4= - 0.077+8.471X18+0.272 X10	0.974	0.971	316.936	0.000
3	Y4= - 3.291+4.298X15+6.653X18 +0.271X10	0.981	0.977	270.911	0.000
4	Y4= - 0.473+6.033X15+10.868X17 +0.272X10	0.989	0.986	479.928	0.000

Where;
Y4= Number of Property damages
X10=Severity Index (S.I)
X15= Number of speed calming (humps or bumps)
X17=Number of pedestrian bridges
X18=Number of pedestrian crosswalk

Models result for the Y2 (number of Fatalities) after adding the additional Accident data

Model number	Dependent variable	R^2	R^2(adjusted)	F-Value	Sig. <0.05
1	Y2=-0.252+ 0.020X10	0.933	0.929	249.831	0.000
2	Y2=0.813- 0.295X7+0.020X10	0.951	0.946	166.085	0.000

Where;
Y2= Number of Fatalities
X7=Number of segments
X10=Severity Index (S.I)

Models result for the Y3 (number of Injuries) after adding the additional Accident data

Model number	Dependent variable	R^2	R^2(adjusted)	F-Value	Sig. <0.05
1	Y3= - 4.724+ 0.184X10	0.989	0.989	1634.492	0.000

Where;
X10=Severity Index (S.I)

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Through the observations of 20 selected streets in a study area and the previous results of the analysis of Traffic accident data, Geometric condition data, Traffic condition data, over the period of the study (2010-2013) for the traffic accidents in the principle urban streets in the Arbil city. The following conclusions can be reached:

1. According to three years of accident government record in Arbil urban area, 20 main streets were selected as High Accident Location HAL out of 30 main streets.
2. The selected HAL streets were considered based on the Severity Index (S.I) of the black spot of the historical accident reports.
3. The statistical analysis results show that the fatalities and injuries accidents are not correlated to the traffic and geometric conditions of the selected streets.
4. The statistical results show that only eight independent variables out of nineteen independent variables are significantly affected on dependent variables (total accident and

property damage) which are: street length(X3), street width(X4), number of lanes(X6), number of segments(X7), traffic density(X9), number of speed calming (humps or bumps)(X15), number of pedestrian bridges(X17), number of pedestrian crosswalks(X18).

5. The statistical results also shows that two independent variables are insignificant effects on dependent variables which are: peak hour volume(X1) and vehicle – km of travel(X11). The other independent variables are excluded from the stepwise regression analysis.
6. Through the geometric conditions and the observation of the 20 selected streets, there are two streets (Qala and Brayati) without median, this situation causes increasing of the traffic accidents rates in these streets.
7. Through the analysis results of the accident data, it was found that increasing in the number of segments will increase the number of total accidents and the number of property damages, and then it will lead to the increasing of traffic accident rates.
8. The increase in the street section length will increase the number of total accidents and increase the number of property damages, this leads to increase the traffic accident rates.
9. Increase the number of pedestrian bridges and the number of pedestrian crosswalks will increase the number of total accidents and increase the number of property damages due to the random distribution of the pedestrian bridges and pedestrian crosswalks then leading to increase the traffic accident rates.
10. Increase the Number of speed calming (humps or bumps) will increase the number of property damages then increase the traffic accident rates.

6.2 Recommendations

According to the previous results the following recommendations can be listed to improve traffic safety in Arbil city:

1. The accident government report in Arbil city should include the causes of traffic accidents due to the driver behaviors and other causes.
2. Including more independent variables regarding the driver behavior may improve the prediction regression accident models.
3. Study the effects of street length and number of segments on increasing of traffic accidents through coordination of signalized and unsignalized intersections or by constructing overpasses or tunnels at the intersections.
4. Relocate the pedestrian bridges and pedestrian crosswalks to reduce their effects on increasing traffic accidents.
5. Using high technology of surveillance such as radars and cameras to reduce the effects of the driver mistakes.
6. Provide median islands on main streets for pedestrian refuge when crossing the wide street.
7. Relocate the speed calming (humps or bumps) to reduce traffic accidents on black spot locations.
8. Develop an awareness programs for drivers and pedestrians through radio and TV media and training courses.
9. Develop an educational traffic safety programs through schools and universities.
10. Increase the low enforcements for speeding, running red light signals, drinking of alcohol, using mobile phone, and yield violation.
11. Using the specification of MUTCD (Manual of Uniform Traffic Control Devices) for warning signs and work zone signs.
12. Using the HCM (Highway Capacity Manual) requirement to evaluate the capacity and level of services on urban streets in Arbil city area.
13. Using an Audit design program to evaluate the geometric design of the main arterial streets.
14. Planning for schools locations not to be located along busy arterials, and applying adequate traffic control devices and cross walks for existing schools.

15. Accuracy in designing and distributing the pedestrian crossing places according to the streets locations such as street crossing: schools, hospitals, mosques, churches, and other public places, where necessary to provide pedestrian crossing on right places.
16. Road construction should be committed to the designed standards that are comparable with international standards.
17. Provide modern public transport to move people from and to their workplaces in order to reduce traffic congestions.
18. Provide parking lots and parking garages on main streets to reduce traffic congestions and to prohibit or constrain the on-street parking.

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Table 1: The Average of Three Years Collected Data and Severity Index for All Main Streets in Arbil City

Street No.	Street Name	Average Fatalities (F)	Average Injuries (I)	Average Property damages (P.D)	Average Total accidents	Severity Index (S.I)	High Accident Location
1	Rasty	___	___	17	17	17	
2	Pirmam	22	216	305	543	1151	HAL
3	koysinjiq	10	100	210	320	600	HAL
4	Khabat	13	72	150	235	483	HAL
5	Baherka	7	24	50	81	185	HAL
6	Makhmur	7	45	86	138	284	HAL
7	Mosul	3	18	32	53	113	HAL
8	Iskan	___	3	22	25	31	HAL
9	kirkuk	2	24	42	68	132	HAL
10	Eynkawa	___	4	20	24	32	HAL
11	Shurash	___	3	22	25	31	HAL
12	Banslawa	1	23	45	69	123	HAL
13	sytakan	___	2	26	28	32	HAL
14	Azady	___	3	27	30	36	HAL
15	Barzany Namir	___	1	16	17	19	
16	Jamal Haydari	___	3	28	31	37	HAL
17	Kurdistan	___	5	70	75	85	HAL
18	Peshewa Qazi	1	15	106	122	160	HAL
19	Qala	3	27	46	76	154	HAL
20	Gulan	___	7	14	21	35	HAL
21	Newroz	___	1	4	5	7	
22	Badawa	1	2	21	24	33	HAL
23	Zanko	___	1	5	6	8	
24	Ashty	___	1	2	3	5	
25	Brayati	1	3	16	20	34	HAL
26	Shahedan	___	1	2	3	5	
27	Risgary	___	1	2	3	5	
28	Shady	___	___	2	2	2	
29	Kwestan	___	___	2	2	2	
30	Chanarok	___	___	3	3	3	

Table 2: Geometric Conditions Data of the Selected Streets

Street No.	Street Name	Street length (km)	Street width (m)	Median width (m)	No. of lanes (for each direction)	No. of segments
2	Pirmam	8.28	35	6	3	5
3	koysinjiq	4.206	35	6	3	4
4	Khabat	0.734	35	6	3	1
5	Baherka	1.65	30	6	2	2

6	**Makhmur**	4.091	35	6	3	3
7	**Mosul**	13	35	6	3	3
8	**Iskan**	3.965	30	6	2	3
9	**kirkuk**	5.852	35	6	3	7
10	**Eynkawa**	2.435	35	6	3	5
11	**Shurash**	1.45	35	6	3	1
12	**Banslawa**	1	30	6	2	1
13	**sytakan**	0.719	30	6	2	1
14	**Azady**	1.938	30	6	2	4
16	**Jamal Haydari**	3.347	30	1.5	2	4
17	**Kurdistan**	9.597	35	6	3	9
18	**Peshewa Qazi**	24.321	30	2.5	3	10
19	**Qala**	1.559	15	0	1	5
20	**Gulan**	5.64	30	1.5	2	5
22	**Badawa**	1.3	30	6	2	1
25	**Brayati**	1.15	20	0	1	1

Table 3: Traffic Data of the Selected Streets

Street No.	Street Name	PHV (veh / hr)	ADT (veh /day)	SMS (km / hr)	K (veh / km)
2	**Pirmam**	2391	36800	30	27.9
3	**Koysinjiq**	1941	29846	42	16.2
4	**Khabat**	2007	30862	16	44
5	**Baherka**	1014	15585	25	21.3
6	**Makhmur**	2079	32000	37	19.7
7	**Mosul**	2040	31385	37	19.3
8	**Iskan**	1020	15692	32	16.8
9	**Kirkuk**	2049	31538	34	21.1
10	**Eynkawa**	2001	30800	25	28.1
11	**Shurash**	2577	39662	22	41.1
12	**Banslawa**	1210	18615	17	37.5
13	**Sytakan**	1050	16154	15	36.8
14	**Azady**	2046	31477	20	53.8
16	**Jamal Haydari**	1994	30677	25	41.9
17	**Kurdistan**	2004	30846	26	27
18	**Peshewa Qazi**	3009	46308	46	22.9
19	**Qala**	1470	22615	13	119
20	**Gulan**	2070	31831	40	27.2
22	**Badawa**	1030	31677	25	21.7
25	**Brayati**	2978	45815	22	142.5

Table 4: The Additional Geometric Conditions Data

Street No.	Street Name	Lane width (m)	Sidewalk width (m)	no. of humps or bumps	No. of ped. bridges	no. of pedestrian crosswalk
2	Pirmam	3.25	4.75	0	0	1
3	koysinjiq	3.25	4.75	5	1	2
4	Khabat	3.25	4.75	1	0	2
5	Baherka	3.5	5	2	0	1
6	Makhmur	3.25	4.75	1	0	0
7	Mosul	3.25	4.75	0	0	0
8	Iskan	3.5	5	0	0	0
9	kirkuk	3.25	4.75	2	1	3
10	Eynkawa	3.25	4.75	2	0	2
11	Shurash	3.25	4.75	2	1	3
12	Banslawa	3.5	5	2	0	2
13	sytakan	3.5	5	1	1	2
14	Azady	3.5	5	0	2	3
16	Jamal Haydari	3.5	7.25	2	0	2
17	Kurdistan	3.25	4.75	0	4	5
18	Peshewa Qazi	3	4.75	6	2	5
19	Qala	3.5	4	1	0	1
20	Gulan	3.5	7.25	2	0	2
22	Badawa	3.5	5	1	0	1
25	Brayati	3.75	6.25	2	0	0

Table 5: The Additional Traffic Conditions Data

Street No.	Street Name	Vehicle - Km of Travel	speed limit (km/hr)	Pedestrian volume (Ped./hr)	%Trucks and Buses
2	Pirmam	304704	60	5	2%
3	koysinjiq	125532.3	80	25	8%
4	Khabat	22652.7	60	67	2%
5	Baherka	25715.3	80	10	25%
6	Makhmur	130912	60	30	24%
7	Mosul	408005	100	7	33%
8	Iskan	62218.8	60	175	20%
9	kirkuk	184560.4	60	204	31%
10	Eynkawa	74998	80	165	7%
11	Shurash	57509.9	60	85	2%
12	Banslawa	18615	80	45	14%
13	sytakan	11614.7	60	38	5%
14	Azady	61002.4	60	179	2%
16	Jamal Haydari	102675.9	60	88	2%

17	**Kurdistan**	296029.1	60	128	7%
18	**Peshewa Qazi**	1126256.9	80	133	34%
19	**Qala**	35256.8	30	200	67%
20	**Gulan**	179526.8	60	95	1%
22	**Badawa**	41180.1	60	57	4%
25	**Brayati**	52687.3	60	89	2%

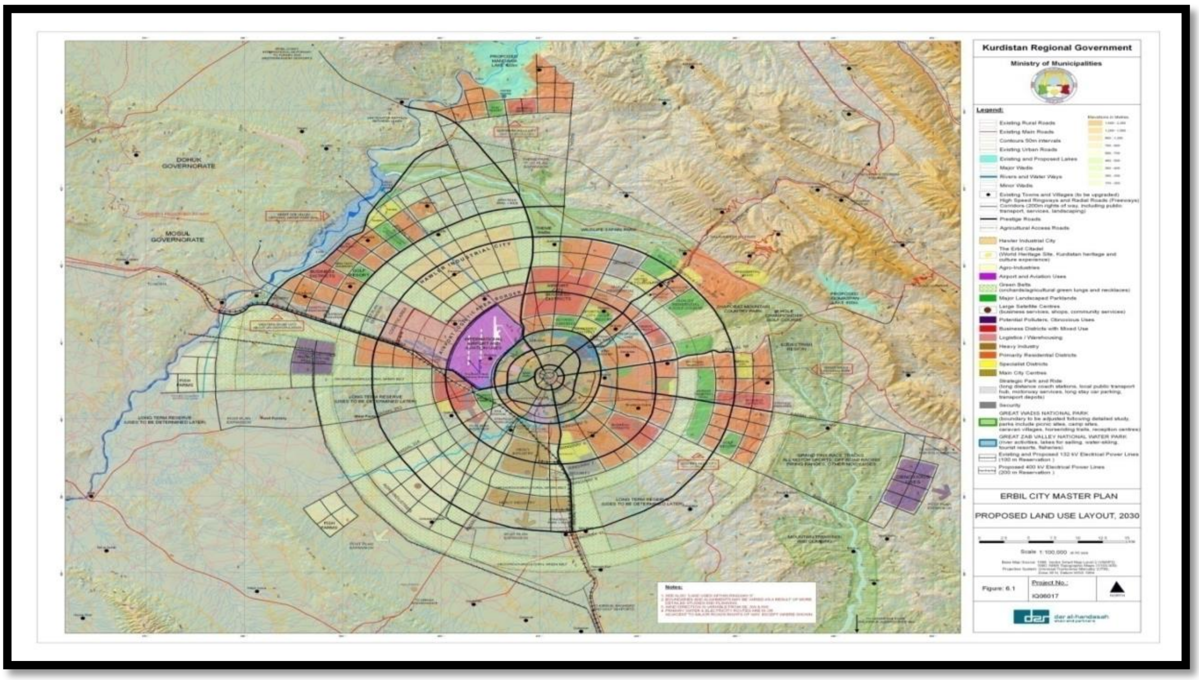

Figure 1: Arbil City Map

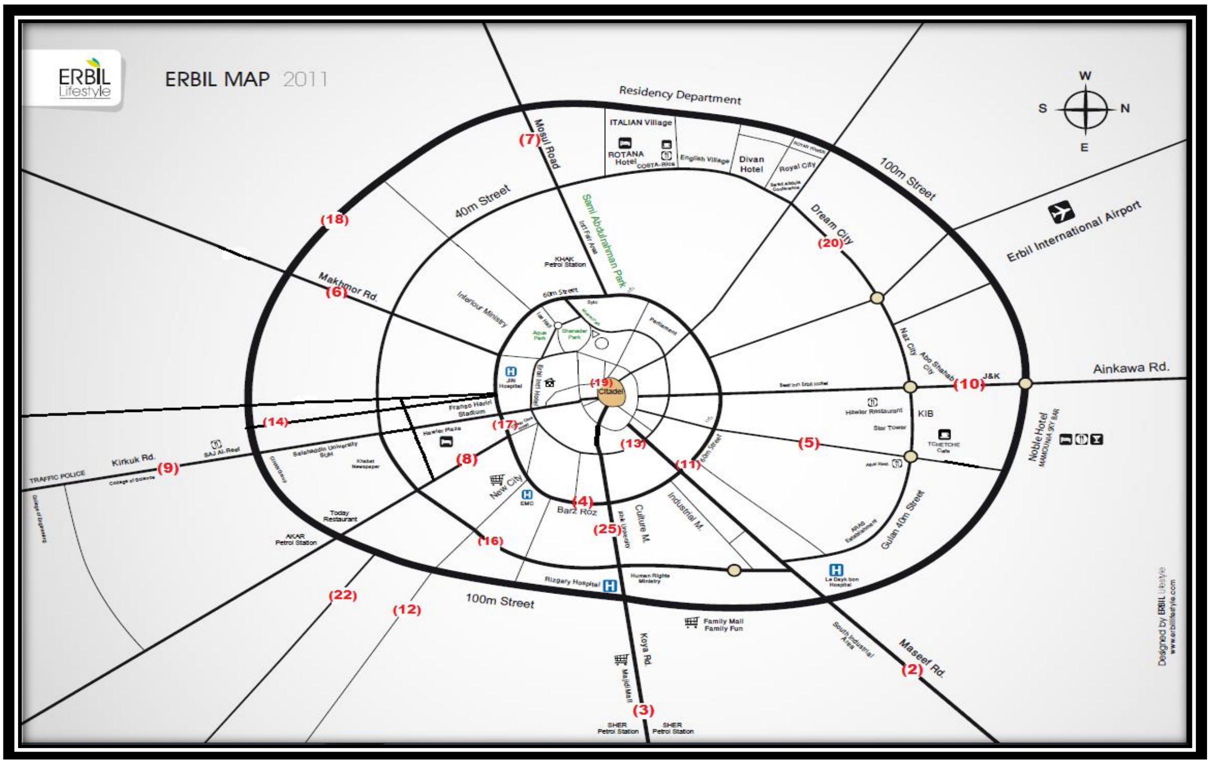

Figure 2: The Distribution of the 20 Selected Streets on the Arbil City Map

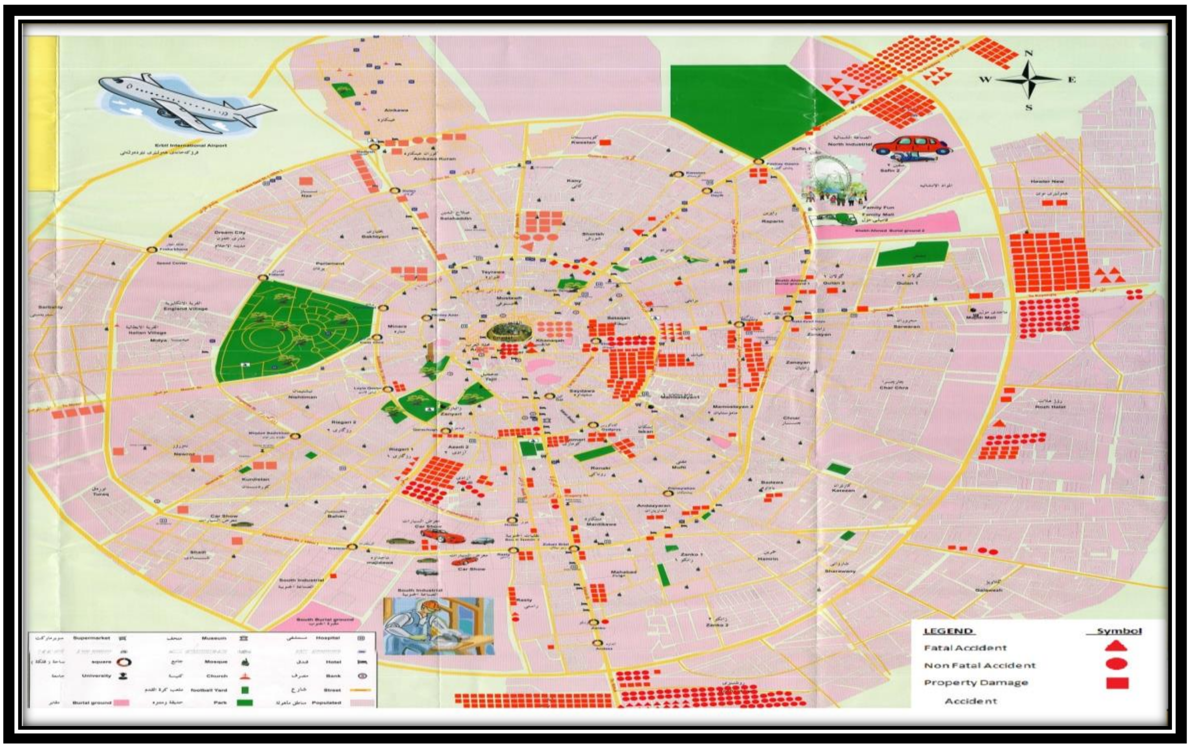

Figure 3: Accident Black Spot Map for the Street Network of Arbil City for Year (2010)