

Spatial Analysis of Traffic Accidents in the AL-Anbar Governorate for the Period (2012-2018)

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The current research deals with spatial analysis of traffic accidents in Anbar province for the duration (2012-2018), as traffic accidents are one of the most important problems which human societies in the world suffer from. It carries in its aspects human, economic, social and psychological characteristics, as it wastes many human energies and money, even if the losses resulting from it are estimated to be spent on other development projects to bring great benefit to society in the study area. The research has adopted the use of (ARC GIS V.10.5) in the analysis of spatial variance of accidents, to determine the levels of variability of accidents and to try to reach the appropriate solutions and radical manners that are consistent with the development of this era.

Key words: *Spatial analysis, traffic accidents, AL-Anbar governorate.*

Introduction

The world is witnessing an advanced technological revolution, the beginnings of this revolution was at the end of the eighteenth century at the time of the industrial revolution, as this revolution had repercussions on human life, it facilitated the way of life and many fundamental difficulties were solved. One of the consequences of this revolution was the shift towards the automotive industry, which made movement easier, the distance travelled increased, and the time between gatherings and other places was reduced. Substantial travel now occurs daily due to daily motor activity and the use of cars for movement. As the use of automobiles has increase so to has the movement of cars has become increasing risky, characterised by roads and infrastructure of poor quality and conditions that lack the support for durability, safety and security. In addition are drivers who are not qualified to drive cars. Therefore, the author has devoted considerable knowledge of sciences, including geography,

in order to study the dimensions and temporal and spatial variables of traffic accident sites and to reveal the most important geographical factors affecting traffic accidents from one location to another. Therefore, the Al Anbar governorate was chosen to be the site of studying traffic accidents as one of the governorates that has witnessed a noticeable rise in the number of traffic accidents, especially after the increase in the number of cars. This study came to reveal one of the most important problems facing the study area, and its reasons. The resulting negative repercussions and attempts to find appropriate solutions and radical manners that are consistent with the evolution of this era.

The Study Problem

Al-Anbar governorate is suffering a clear deterioration in the transport system, although it is one of the largest provinces in Iraq, due to the entry of large numbers of vehicles, that has caused great pressure on the roads, and affected the efficiency and effectiveness of that system. Resulting in a significant increase in the number of traffic accidents, so the problem of studying lies in the following questions: Does the transport system in the study area have an impact on the spatial distribution of traffic accidents?

Research Hypothesis

The transport system in the study area varies spatially.

The Significance of Study

The purpose of the spatial analysis of traffic accidents for the roads of Al-Anbar province for the duration (2012-2018) is to highlight the reality of accidents in the province. Accidents here have increased significantly, resulting in short- and long-term social and economic problems. This requires the study of the causes of accidents and spatial analysis of them, given their critical importance in analysing these incidents and their seriousness and working with the focus on these places by the responsible authorities to raise awareness of citizens and to emphasise the procedures for granting driver's licenses and preparing training courses for motorists to significantly reduce the risk of accidents.

Study Objectives

The study aims at using spatial analysis of traffic accidents in the Province of AL-Anbar, through its spatial dimension, as well as the diagnosis of the underlying causes of accidents, through data, tables and topographic maps for the purpose of giving a clearer picture of the seriousness of these accidents and the negative effects of them for both the individual and society.



The Limits of the Study Area

Spatial Limits

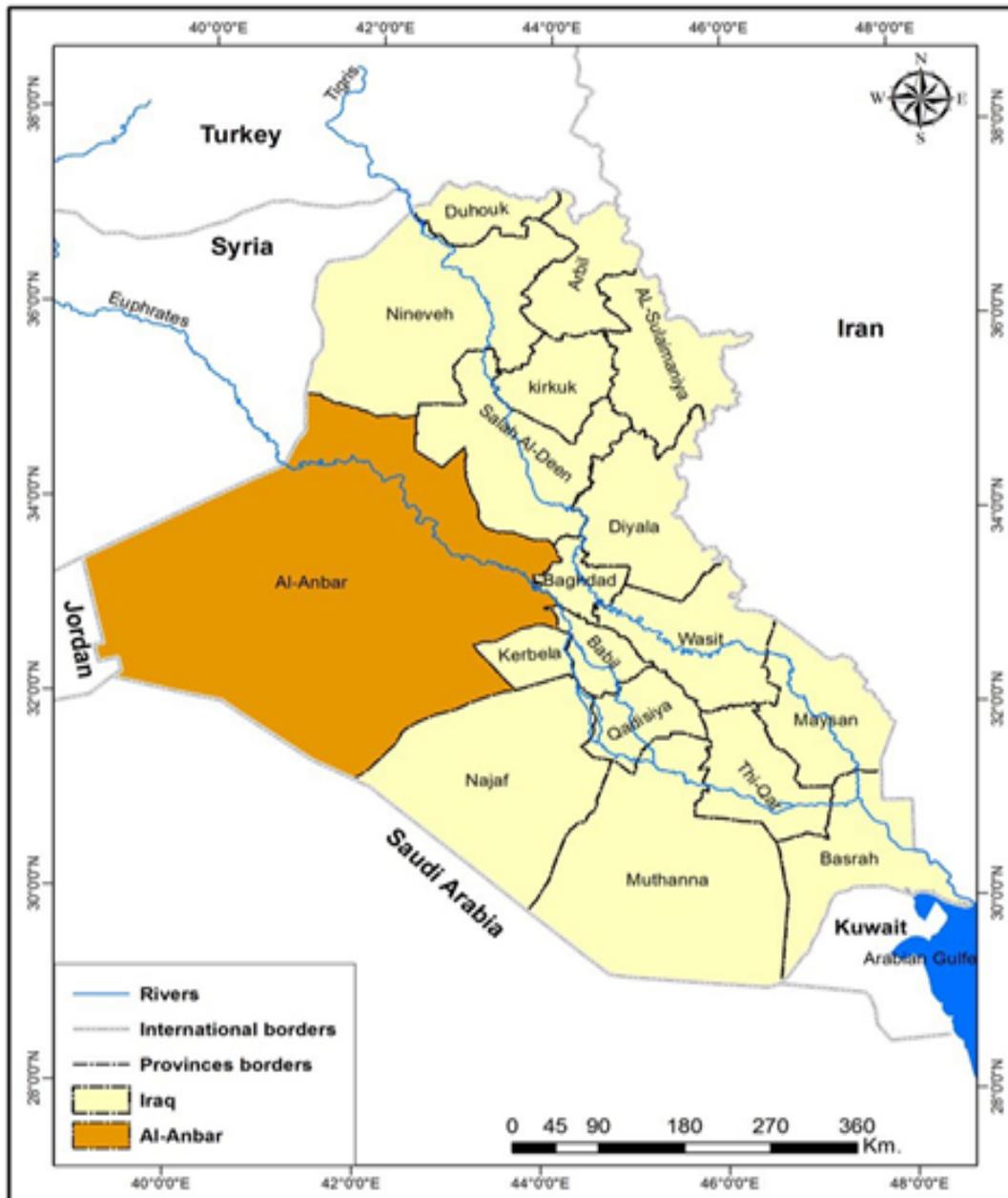
The study area was determined by the administrative boundaries within the western section of Iraq between a latitude (18, 30-17, 35) approximately north, and longitude (50, 38-14, 44) approximately east.

The study area is administratively limited by governorates in Nineveh governorates from the north, Salah al-Din from the north-east, Bagdad governorate from the east, south-east and south of Babil, Karbala and Najaf map (1)

The Temporal Limits

The temporal limits of the study area relied on the data recorded for traffic accidents in the General Traffic Directorate and the Anbar Governorate Traffic Directorate and the Anbar Governorate Police Directorate for the years (2012-2018), with all its administrative units, but due to the security conditions and the occupation of the province by ISIS terrorist groups, it was not possible to record accidents for the year (2015).

Map 1. Study area location



Source: Ministry of Water Resources, General Survey Authority , Map Production Unit, Digital Unit, Iraq Administrative Map, Scale (1:100,000) for the year (2010).

1- Spatial Relationships and Traffic Accidents

One of the priorities of geography is to study the spatial relationship of phenomena between different regions of the Earth's surface. It is an attempt to understand the complementarity and correlation between phenomenon and the Earth's surface and demonstrate this integration. This integration does not appear except through geography, which is represented

in the form of a map that the researcher must present and explain the results reached by him and develop proposals to solve it.¹

Traffic accidents are often distributed spatially on the roads, subject to many human and natural factors. What increases the risk of accidents is that they are not confined in one place and at a specific time but are expected to occur in all places and times, and increase in one place and decrease in another, so the geographer must know the reasons for their increase in one place and the reasons for decrease in another²

Traffic accidents often occur in places with highways, main intersections and places of high populations that provide the largest number of pedestrians mixed with vehicles. These areas are exemplified in shopping malls, schools, government departments, etc., and are reduced in areas that are free from previous causes, whereas places where traffic accidents are frequent and occur in the same location are called "black spots"³

2- Spatial Analysis of Traffic Accidents by Location and Type of Occurrence

The location of traffic accidents on the roads varies, since it is an emergency and unintentional occurrence, it may vary from one place to another, so we find an increase in number of accidents within urban areas, especially intersections, pedestrian areas and districts, resulting in accidents within this area.⁴

The number of accidents in Anbar Governorate (the study area) varied within their administrative units, as the total traffic accidents during the study period (2012-2018) reached (1825) traffic accidents, as they were distributed as shown in Table (1) and Map (2), through analyzing its incoming data that the rates of occurrence and spatial distribution differed from one district to another and for reasons that are mentioned above are according to the category that was divided into differing levels:

1- Level 1 (0.14-1.69): In this category, the district of Ramadi, which recorded the highest total of accidents, accounted for 478 incidents or 26.1 per cent. Of the total road accidents

¹ Emad Nasser al-Mutairi, using some statistical indicators in the seriousness of traffic accidents, Nayef Arab University for Security Sciences, Riyadh, Saudi Arabia, 2005, p. 11.

² Noor Ahmad Qash, Spatial Distribution of Traffic Accidents in the City of Nablus in the Period (2000-2012) by Geographic Information Systems, Unpublished Master Thesis, Faculty of post-graduate, An-Najah University, Nablus, 2013, p. 40.

³ Musaad Syed Ahmed Buhairi, Spatial analysis of traffic accidents in the Kingdom of Saudi Arabia, 2005-2015, using geographical information systems, Ain Shams Magazine, Egypt, No. (20), 2016, p. 78

⁴ Omar Abdul Nabi, Standard Specifications for Safety in The Car and Road, First Edition, Arab Center for Security Studies, Training and Publishing, Riyadh, Saudi Arabia, 1988, p. 94

in the study area, the standard score (1.96). Then, the Fallujah district is followed by a total of (346) accidents at a rate of (18.9%), while its standard score was (1.03). The reasons for the increase in accidents in both Ramadi and Fallujah districts can be attributed to the fact that they are densely populated districts where most government institutions and departments are concentrated, with educational and health institutions in them, in addition to al-Qaim district, where the total number of traffic accidents (270) accidents and percentage (14.8%) Its standard score was 0.48, due to the traffic activity in the judiciary as a border post between Iraq and Syria.

- 2- The second level (0.13- 0.63): The districts (Al-Rutba - Hit - Al-Habbaniyah) were counted within this level, as (221) accidents were recorded in Al-Rutba district, at a rate of (12.1%) and a standard score (0.13), while it was recorded The Hit District (134) accidents with a rate of (7.3%) and a standard score (-0.49), while the Habbaniyah district recorded (127) accidents with a rate of (6.9%) and a standard score (-0.54) The cause of the accidents in it is attributed to the presence of government institutions, as well as the fact that the Rutba District is one of the largest districts and the passage of the international highway connecting Iraq, Jordan and Syria, which has increased the traffic density. In addition to the negligence and lack of maintenance of roads, which has led to an increase in accidents, the Habbaniya district witnessed large numbers of accidents due to its occurrence between two important district densities with a high population density, which is the Governorate Center (Ramadi and Fallujah District), this area has the highest population density in the province.
- 3- The third level (-0.64_ -1.05): Included in this level are each of the districts (Rawah - Haditha - Anna), and the decrease in accidents rates in them is due to the small population compared to the rest of the districts, in addition to that the Haditha district, Anna and Rawah, are far from the centres of economic activity. Their low population density, constituted a clear decrease in traffic and thus a decrease in the number of traffic accidents. It is noted in what was mentioned in the previous levels that the distribution of traffic accidents geographically in the study area was characterised by variation and disorganisation, it has increased in densely populated districts with government centres and commercial, economic and service activities, and decreased in districts that lack population and services.

Table 1: Relative distribution of traffic accidents in Anbar province for the duration (2012-2018) by administrative units and standard score

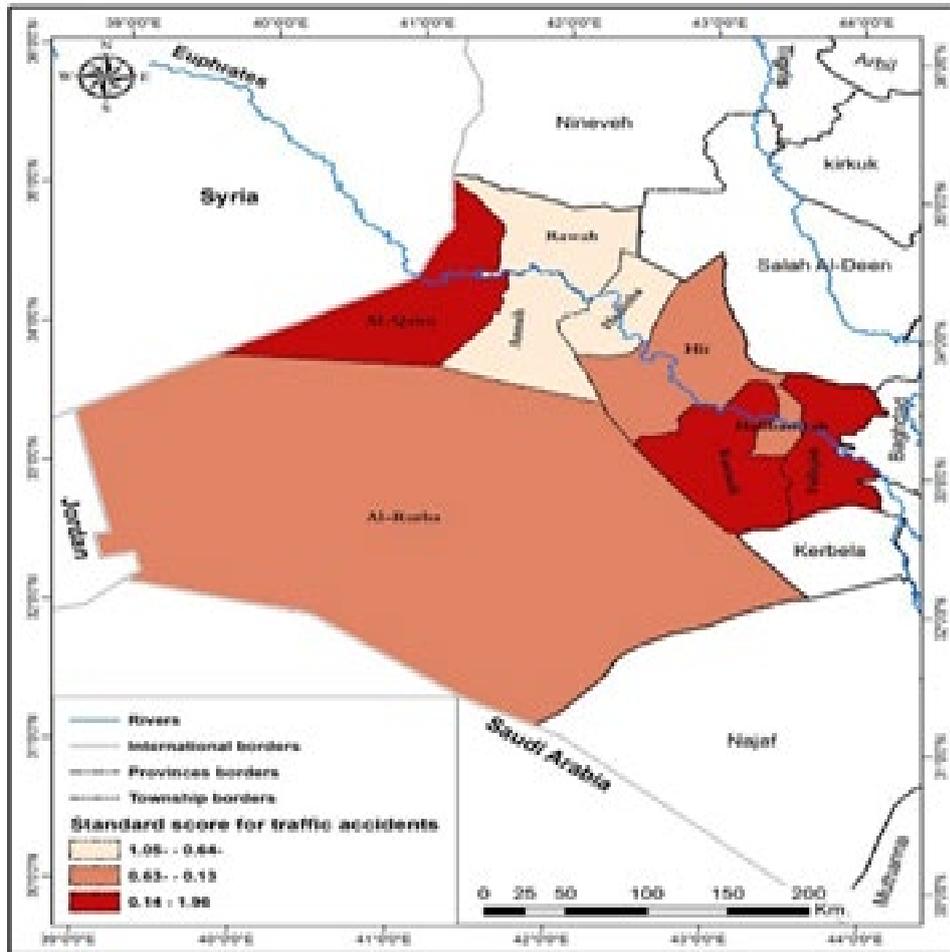
Standard Score ⁵	Percentage%	The number of accidents	District
1.96	26,1	478	Ramadi
1.03	18.9	346	Fallujah
0,54-	6,9	127	Habbaniyah
0,49-	7.3	134	Hit
0,64-	6.2	113	Haditha
0,87-	4.4	81	Annah
1,05-	3,0	55	Rawah
0,48	14,8	270	Al-Qaim
0,13	12.1	221	Al-Rutba
————	%100	1825	Total

Source: From the work of the researcher based on Republic of Iraq, Ministry of Interior, Directorate of Traffic of Al-Anbar Province, Planning and Statistics Division, Unpublished Data, 2018

The standard score was extracted by the researcher according to the statistical equation $D = \frac{X - \mu}{\sigma}$
Where; D = standard score. μ = the mean of the variable values. X = any of the variable values. σ = standard deviation For more information, see:

Ahmad Abdul Samee, Thebes, Principles of Statistics, Dar Al-Bedaya, 1st Ed., Amman, Jordan, 2008, p. 101.

Map 2. Traffic accidents according to administrative units and standard score in AL- Anbar province For duration (2012-2018)



Source from the researcher's work, relying on:

- 1- Republic of Iraq, Ministry of Water Resources, Survey Authority, Maps Production Division, Anbar Governorate Administrative Map, scale (1: 500000) for the year 2018.
- 2-Table No. (1).

3-Accidents

When referring to the number of traffic accidents, according to the type of accident, collision accidents ranked first in all types of accidents, as the total accidents in the study area during the period (2012-2018) were (1347) accidents with a percentage of (73.8%) of the total of the remaining types of accidents recorded in the Governorate.

When reviewing Table (2) and Map (3), the random distribution of this type of accident between the administrative units in the Governorate is clear. Therefore, it was distributed spatially to the following levels according to its standard score:

1- The first level and the confined category (2.03 _ -0.42): It was within this level that the Ramadi-Fallujah-Habbaniyah district had a total of 695 accidents with a percentage of 51.5% of the total number of collision accidents in the Governorate, as the number of accidents reached (339) (240) (116) accidents, the percentage of (25.2%) (17.8%) (8.6%) and a standard score (2.03) (0.96) (-0.36) respectively and the reason was that the high rate of collision accidents in the district was due to the density of population numbers and increased traffic, in addition to the location of this central district, which has made entry and exit largely from the fact that the Ramadi district is the centre of the Governorate and the important economic factors as the substantial centre for the active commercial movement made the highest levels of collisions.

2-The second level: The confined category (-0.43 _ -0.64): This category was confined to the districts (Hit - Rutba - Haditha) with the number of accidents (110) (106) (90) accidents with proportions (8,2%) (7. 9%). (6.6%) and with a standard degree (-0.43) (-0.47) (-0.64), respectively, with a total of accidents of (306) and a total of (22.7%) of the total number of collision accidents in the governorate. The reason for this number of accidents was the fact that the Rutba District is one of the largest districts in the Governorate and contains the highway linking Iraq, Jordan and Syria passes, while the Hit and Haditha districts due to the small area and medium population density made the number of collision accidents increase in these districts.

3- The third level of the confined category (-0.65 _ -0.94) was limited to the category of districts (Anah, Rawa , Al-Qaim) by the number of accidents amounted to (346) accidents or (25.6%) of the total accidents in the province, they formed a standard score (-0.82), (-0.94). (-0.65). The decrease in the number of accidents in these districts was due to the decrease in the number of vehicles in addition to the decrease in the density of the population, as compared to the rest of the province districts, and the small area of the district excluding the district of Al-Qaim, which is experiencing a medium population density, these factors combined helped to reduce the number of collisions in these The districts.

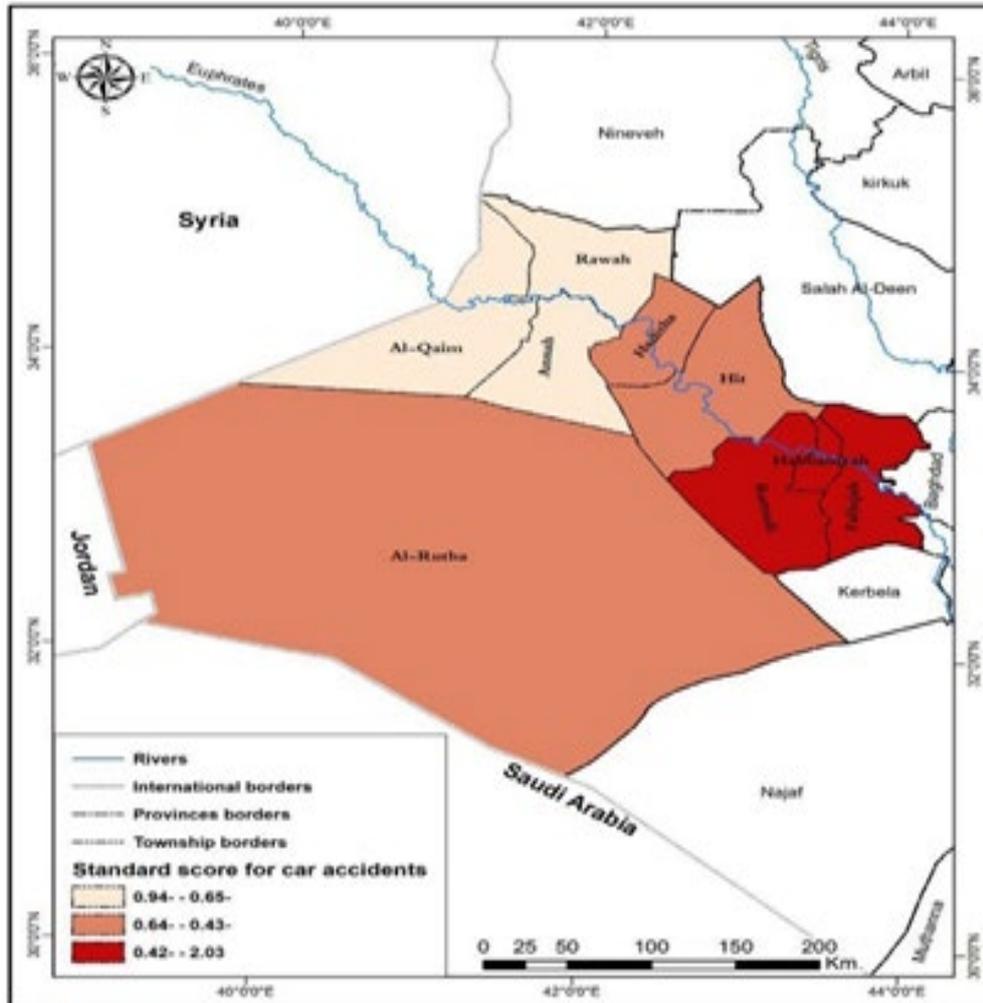
Table 2: Relative distribution of collision incidents in AL-Anbar Governorate for the period (2012-2018) by administrative unit

Standard Score	Percentage%	The number of accidents	district
2.03	25,2	339	Ramadi
0.96	17,8	240	Fallujah
0.36	8,6	116	Habbaniyah
0.43	8,2	110	Hit
0.64	6,6	90	Haditha
0.82	5,4	73	Annah
0.94	4,6	62	Rawah
0.65	15,7	211	Al-Qaim
0.47	7,9	106	Al-Rutba
-----	%100	1347	Total

Source: From the work of the researcher based on: -

- 1- Republic of Iraq, Ministry of Interior, AL- Anbar Traffic Directorate, Planning and Statistics Division, Unpublished Data, 2018.
- 2- Republic of Iraq, Ministry of Interior, AL-Anbar Police Directorate, Statistics Division, unpublished data, 2018.

Map 3. Collisions by administrative units and standard score in AL-Anbar Province For the duration (2012-2018)



Source from the researcher's work, relying on:

- 1- Republic of Iraq, Ministry of Water Resources, Survey Authority, Maps Production Division, AL-Anbar Governorate Administrative Map, scale (1: 500000) for the year 2018.
- 2- Table No. (2).

4- Run Over Accidents

Run-over type accidents were ranked second among traffic accidents in the study area, with a total of 217 accidents, and the number of accidents was 11.9 per cent of the total number of accidents.

Through the results of Table (3) and Map (4) the irregular distribution of them according to the levels of each administrative unit in the province, and in light of this it was divided into levels based on the standard score of each district and as follows:

- 1- The first level, the confined category (0.21_2.02): - This level represents the districts (Ramadi, Fallujah, Al-Qaim) with the number of total accidents (143) and with a total percentage (65.8%) and distributed according to figure (65), (47), (31). Accident and percentages (29.9%), (21.7%), (14.3%) and standard score (2.02), (1.13) and (0.34), respectively. The reason for the high numbers is that this district represents the highest population density in the study area, which has increased their mixing with transportation and increases pedestrians exposure to being run over. In addition the presence of schools on the roads and main streets, increased the chances of accidents, especially among children who are usually less careful and cautious when using the road.

The second level, the confined category (0.20_-0.68) within this districts (Hit, Habbaniyah, and Rutbah), with a total number of accidents (52) accidents, at a rate of (23.9%), as it reached as follows (15), (17), (20) (6.9%), (7.8%), (9.2%), and a standard score (0.45), (0.35), (9.2), respectively, and the reason was the average population density in the Hit district and a low population density in the Rutba district. This district, as well as the excesses that occur on the road, as it witnessed a residential and governmental building movement on areas of the road supposed to be part of the road, which made it a cause of run over accidents.

- 2- The third level: the confined category (-0.69_-0.95). This category included the districts of (Rawah-Anah-Haditha) with a total number of accidents (22) and a percentage of (10.1%), distributed among (5) (7) (10) accidents with a percentage of (2.3%) (3.2%) (4.6%) and a standard score (-0.95), (- 0.85), (- 0.69), respectively, and this is due to the low number of residents and the good planning of most of its departments and schools, although they are fewer, they are situated far from the road and main streets, which has led to a decrease in the rates of run-in incidents.

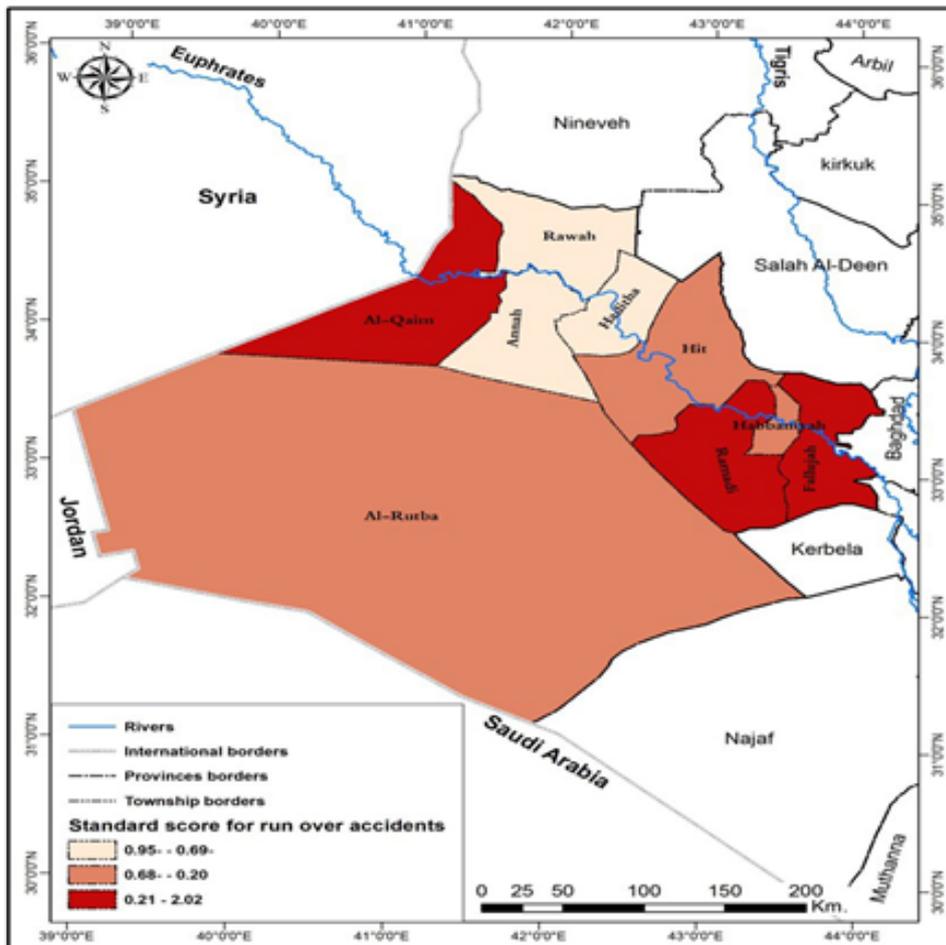
Table 3: Relative distribution of run-over incidents in Anbar province for the duration (2012-2018) by administrative units and standard score

Standard Score	Percentage%	The number of accident	district
2.02	29.9	65	Ramadi
1.13	21.7	47	Fallujah
0.35-	7.8	17	Habbaniyah
0.45-	6.9	15	Hit
0.69-	4.6	10	Haditha
0.85-	3.2	7	Annah
0.95-	2.3	5	Rawah
0.34	14.3	31	Al-Qaim
0.20	9.2	20	Al-Rutba
----	%100	217	Total

Source: From the work of the researcher relying on:

- 1- Republic of Iraq, Ministry of Interior, Anbar Governorate Traffic Directorate, Planning and Statistics Division, unpublished data, 2018.
- 2-Iraq, Ministry of Interior, Anbar Police Directorate, Statistics Division, unpublished data, 2018.

Map 4. Run over accidents, according to the administrative units and the standard score in AL- Anbar Governorate
Duration (2012-2018)



Source from the researcher's work, relying on:

- 1- Republic of Iraq, Ministry of Water Resources, Survey Authority, Maps Production Division, AL- Anbar Governorate Administrative Map, scale (1: 500000) for the year 2018.
- 2-Table No. (4).

5- Coup Accidents

These incidents are characterised as the most dangerous type of traffic accident, often resulting in adverse in human terms. In terms of material and economic damage, it costs more than other accidents because it always results in greater damage to vehicles, which can result in total damage to the vehicle, while damage to the environment surrounding the coup site is often higher, resulting in damage to the road corridor and surrounding fences if any, in addition to the deterioration of the road.. Therefore, the number of coup accidents in the study

area reached (210) accidents, at a rate of (11.5%) of the total number of accidents in the province during the study. Table (4) and Map (5) have shown that the coup incidents were distributed in a regular and equal manner among the administrative units of the governorate, and in order to determine their locations more accurately, they were divided into the following levels: -

1-The first level of the confined category (2.02_-0.16) includes the districts (Al-Rutba, Ramadi, and Fallujah). These districts contributed to the number of accidents (156) and by (74.3%) and came in the order (70) (47) (39) accidents and by (33.3%), (22.4%), (18.6) and with a standard degree (2.02) and (1.03) (0.68), respectively. The accident numbers were caused by the large population of Ramadi and Fallujah, as well as the lack of maintenance and neglect of roads led to an increase in the number of accidents, and the Al-Ratba district is witnessing a large traffic flow, the extension of the highway, and the large number of bumps and the destruction of bridges by ISIS and the lack of maintenance work has increased the number of incidents.

2-The second level, the confined category (-0.17_-0.56), which includes the districts of (Al-Qa'im, Habbaniyah), with a total of (24) accidents, at a rate of (6.2%), (5.2%), and with a standard score (0.45), (-0.53). The reason for the level of these accidents is due to the average size of the population and the poor roads that are generally two lanes, in addition to recklessness by motorists.

Table 4: Relative distribution of coup accidents in AL-Anbar governorate for the period (2012-2018) according to administrative units and standard score.

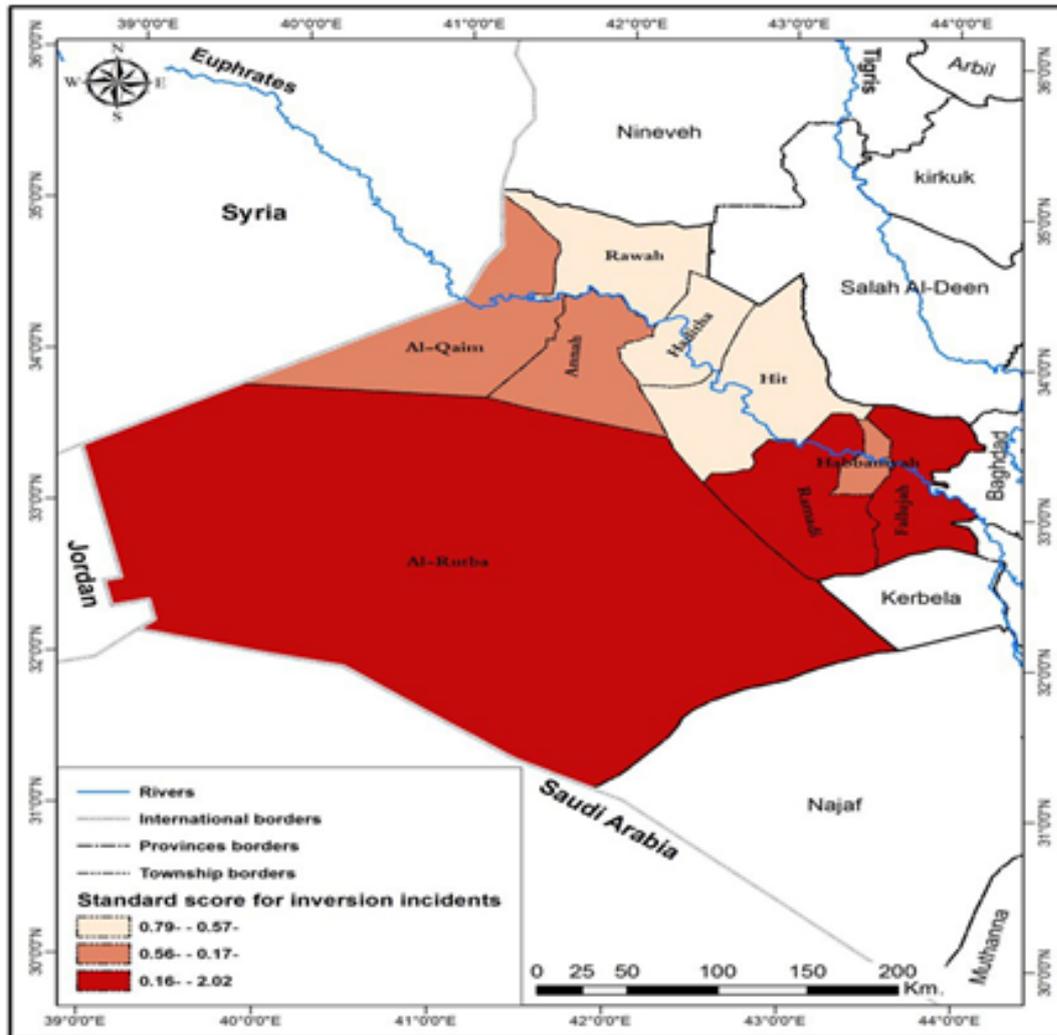
Standard Score	Percentage%	The number of accidents	district
1.03	22.4	47	Ramadi
0.68	18.6	39	Fallujah
0.53-	5.2	11	Habbaniyah
0.57-	4.8	10	Hit
0.66-	3.8	8	Haditha
0.71-	3.3	7	Annah
0.79-	2.4	5	Rawah
0.45-	6.2	13	Al-Qaim
2.02	33.3	70	Al-Rutba
---	%100	210	Total

Source: From the work of the researcher based on: -

1- Republic of Iraq, Ministry of Interior, Anbar Traffic Directorate, Planning and Statistics Division, Unpublished Data, 2018

2-Republic of Iraq, Ministry of Interior, Anbar Police Directorate, Statistics Division, Unpublished Data, 2018.

Map 5. Coup Accidents by Administrative Units and the Standard Class in AL-Anbar governorate
For the duration (2012-2018)



Source from the researcher's work, relying on:

- 1- Republic of Iraq, Ministry of Water Resources, Survey Authority, Maps Production Division, AL-Anbar Governorate Administrative Map, scale (1: 500000) for the year 2018.
- 2- Table No. (5).

Conclusions

- 1- The study showed that the Ramadi district obtained the highest number of accidents, as it reached (478) accidents at a rate of (1.26%) and with a standard degree (0.96). With a standard score (0.3), while the Hit district recorded (134) accidents at a rate of (7.3%) and a standard score (-0.49), while the Habbaniyah district recorded (127) accidents at a rate of (6.9%), and with a standard score (-0.54).
- 2- As for the third level, each of the Rawa districts, Haditha, and Annah.
- 3- -As for collision accidents, Ramadi, Fallujah, and Habbaniyah district had the highest number of accidents (339), (240), (116) and a standard score (2.03), (0.96), (0.36), while the second level was confined to the Hit district, Rutabh, and Hadutha and with a standard score (-0.43), (- 0.47), (- 0.64). As for the third level, it is confined to the district of Annah, Rawa, and Al-Qaim, and a standard score (-0.82), (-0.94), (- 0.65).
- 4- The incidents of run-off came in the first level and standard score (2.02), the second and third level were within the District of Hit and with a standard score (-0.45) while the District of Rawa was at the third level and with a standard score (-0.95).
- 5- As for the coup incidents, the first level came from the Rutba district with a standard score (2.02), while the second-level district Al-Qaim came with a standard score (-0.45), while the third level was the Hit district with a standard score (-0.57).

Recommendations

- 1- Expanding the network of transportation roads in AL-Anbar governorate and establishing new roads that contribute to reducing traffic intensity on the roads, especially the main ones.
- 2- Maintenance of the road network in the province, as it was destroyed during the period of ISIS occupation of the province.
- 3- Stricter implementation of the traffic laws against violators and not granting driving licenses without real controls and tests.



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