




## An Analytical Study to Investigate the Effect of Speed Control Cameras in Reducing Traffic Accidents

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### Abstract

In this study, the effect of speed control cameras on traffic accidents in Dohuk province of Iraqi Kurdistan Region is analyzed using data from 2011-2019. Three time periods: before, during and after the installation of cameras were used as criteria for the retrospective detection of traffic accidents. For control purposes, an area in the same region where the cameras were not installed was also included in the study. The importance of this research is that traffic accidents occur at high rates due to the increasing number of vehicles and speed violations in the province every year. It is of great importance to take measures to reduce vehicle speeds in order to reduce traffic accidents. By reducing vehicle speeds, traffic congestion on the roads and loss of life in accidents can be reduced. More speed control cameras are being used in the belief that they will reduce vehicle speeds. In Duhok province, the annual average number of vehicles increased by 7.62% and the number of speed-related traffic violations increased by 34.46%, while the number of traffic accidents increased by 4%, the number of injuries due to traffic accidents increased by 5.32% and the number of deaths increased by 1.86%. SPSS package program was used for the necessary analyses.

**Keywords:** Speed cameras, traffic accident, drivers, vehicle.

## Trafik Kazalarının Azaltılmasında Hız Kontrol Kameralarının Etkisini İncelemeye Yönelik Analitik Bir Çalışma

### Özet

Bu çalışmada, Irak Kürdistan Bölgesi'nin Dohuk ilinde hız kontrol kameralarının trafik kazaları üzerindeki etkisi 2011-2019 yılları arasındaki veriler kullanılarak analiz edilmiştir. Trafik kazalarının geriye dönük tespiti için kameraların kurulumundan önce, kurulum sırasında ve sonrasında olmak üzere üç zaman dilimi kriter olarak kullanılmıştır. Kontrol amacıyla, aynı bölgede kameraların kurulmadığı bir alan da çalışmaya dahil edilmiştir. Bu araştırmanın önemi, ilde her yıl artan araç sayısı ve hız ihlalleri nedeniyle trafik kazalarının yüksek oranlarda meydana gelmesidir. Trafik kazalarının azaltılması için araç hızlarının düşürülmesine yönelik tedbirlerin alınması büyük önem taşımaktadır. Araç hızlarının düşürülmesi ile yollardaki trafik sıkışıklığı ve kazalardaki can kayıpları azaltılabilir. Araç hızlarını azaltacağı düşüncesiyle daha fazla hız kontrol kamerası kullanılmaktadır. Duhok ilinde yıllık ortalama araç sayısı %7,62 ve hıza bağlı trafik ihlali sayısı %34,46 artarken, trafik kazası sayısı %4, trafik kazalarına bağlı yaralanma sayısı %5,32 ve ölüm sayısı %1,86 artmıştır. Gerekli analizler için SPSS paket programı kullanılmıştır.

**Anahtar Kelimeler:** Hız kameraları, trafik kazası, sürücü, araç

## **Introduction**

Traffic accidents are among the major causes of death and disability. Approximately 50 million people are injured or disabled and 1.2 million people die in traffic accidents every year in the world. In the coming years, traffic accident rates are expected to increase and deaths due to traffic accidents are expected to rise from ninth to third place in the world (Pilkington and Kinra, 2005). The travelling speed of vehicles is one of the most important factors for death or injury. The faster the vehicle is moving; the more energy passengers are exposed to during a collision and the greater of injury. Excessive speed, which is defined as travelling faster than the set limits or too fast for the existing conditions, has significant effects on accidents. If the number of speeding drivers is reduced, it is expected that the probability of accidents and the severity of accidents will decrease. Therefore, measures should be taken to reduce vehicle speed in order to prevent injuries and deaths in traffic accidents. Speed control cameras and related automatic devices are among the safe speed control methods (Wilson, et.al., 2010). Speed cameras are used in many countries around the world and are becoming more widespread. However, the use of speed cameras is not without controversy. There are some organizations that oppose the use of speed cameras and their use is often criticized in the media. Evidence on the effectiveness of speed cameras is controversial, making it difficult for road safety and health professionals to get involved (Pilkington and Kinra, 2005).

When the statistics obtained from the Traffic Directorate of Duhok Province are analyzed, it is revealed that there is an increase in both the number of traffic accidents and the number of deaths and injuries with the increase in speed violations. From this point of view, the research problem was formed by formulating the research questions as follows.

- What is the number of traffic accidents?
- What are the causes of traffic accidents?
- Do speed control cameras contribute to reducing accidents, injuries and deaths resulting from accidents?

The importance of this research is that traffic accidents occur at high rates in the province every year due to the increasing number of vehicles and speed violations. In addition, it is to study a problem that concerns economic, health, social and security units. It is important to know the causes and prevention methods by determining the number of traffic accidents. Identifying traffic accident indicators facilitates the selection of appropriate planning processes for the future. Thus, accidents can be reduced and the economic costs associated with traffic accidents in the province can be minimized.

These measures also aim to reduce traffic speed and the use of speed control cameras is one of these measures. The use of speed control cameras is considered necessary in order to reduce traffic accidents and related injuries and deaths.

## **Literature Reviews**

It was emphasized by Newstead and Cameron (2003) that speed cameras began to be used in Queensland as of May 1, 1997. Using data from this date until the end of June 2001, they investigated how speed cameras affected accident rates in the area within a 6 km radius of the speed camera area. It has been determined that there is a 45% decrease in fatal accidents in the 2 km radius area when speed cameras operate in the maximum coverage area. It was determined that there was a 31% decrease in hospitalizations, a 39%

decrease in medical treatment, a 19% decrease in other injury accidents and a 21% decrease in non-injury accidents. Additionally, these results were evaluated in terms of total annual traffic accidents and significant reductions were observed when the results were generalized across the country. In conclusion; it was estimated that a total cost saving of 47% was achieved from the beginning to the end of the study.

Pilkington and Kinra (2005) evaluated how fixed or mobile speed cameras affect traffic accidents and related fatalities. For this purpose, fourteen observational studies were examined, and in thirteen of them was emphasized that the cameras were effective in three years or less, and in one of them was emphasized that they were effective in a longer time. The results showed that cameras were effective in reducing crashes by between 5% and 69%, injuries by between 12% and 65%, and fatal crashes in the immediate vicinity of camera sites by between 17% and 71%. In conclusion, existing research suggests that speed cameras may be an effective intervention to reduce traffic accidents and related fatalities, but most studies do not provide satisfactory comparisons, making the level of evidence relatively weak.

Wilson et al. (2010) argues that injuries resulting from traffic accidents are of global public health importance, and with this rapid increase, they will rise to the top of the global disease list. Therefore, the use of speed cameras is considered important. This study evaluated whether speed cameras can reduce traffic accidents, deaths and injuries due to excessive speed. The study is based on 35 previous studies. The relative reduction in average speed ranged from 1% to 15% and the proportion of speeding vehicles ranged from 14% to 65%. Around the camera area, before/after reductions ranged from 8% to 49% for all crashes and from 11% to 44% for fatal and serious injury crashes. Furthermore, the improvement in pre/post injury accident rates ranged from 8% to 50%. In conclusion, despite the variability in signal noise levels and methodological limitations, the consistency of speed and crash reductions across all studies suggests that speed enforcement cameras are a valuable method for reducing traffic crash injuries and fatalities.

Li et al. (2013) tried to determine the effects of speed control cameras on reducing traffic accidents in the UK. Using the Propensity Score Matching (PSM) method, they compared the Naïve before-after approach and the Empirical Bayes (EB) method with PSM. For the study, 4787 and 771 field data were obtained for the control and treatment groups respectively for 9 years in the UK. Both EB and PSM methods yielded similar results, with a significant reduction in the number of all serious accidents occurring where speed cameras were installed. It was emphasized that PSM can be used as a criterion for selecting the reference group in before-after control studies. Speed cameras were most effective in reducing accidents 200 meters away from the camera location.

Tang (2017) argues that penalizing drivers who exceed speed limits will reduce traffic accidents and evaluates whether speed enforcement cameras used to identify drivers exceeding speed limits reduce the severity and number of traffic accidents. A study in Great Britain found that speed cameras significantly improved road safety. According to the study findings, the installation of 1000 cameras prevented approximately 1130 collisions and 330 serious injury accidents, saving 190 lives per year and generating a net benefit of approximately £21 million. The conclusion was that these effects were highly localized nearby camera and spread as the distance increased, with more crashes occurring further away from the cameras.

Borsati et al. (2019) emphasize that at the end of 2005, Autos trade per l'Italia and the Italian traffic police introduced an average speed monitoring system called Safety

Tutor on a long stretch of the Italian toll highway network to encourage drivers to obey speed limits and improve driving safety. In their study, they empirically determine the extent to which Safety Tutor has been effective in reducing total and fatal accidents on Italian highways between 2001 and 2017. The results show that a 10% increase in Safety Tutor coverage leads to an average reduction of 3.9% in total accidents, but there is no evidence that Safety Tutor has a significant causal effect in reducing fatal accidents.

## **Material and Methods**

### **Speeding and surveillance cameras**

Speeding is defined as driver behavior that exceeds the set limit or drives too fast for the conditions. Speed is considered to be a factor affecting a significant proportion of fatal and non-fatal accidents (Forrest M. and others. 2017). This is because exceeding the permitted speed limits or speeds that are not appropriate for road conditions or traffic affect both accident probability and accident outcomes. In other words, speed reduces the possibility of maneuvering in time to avoid the hazard and causes accidents on a scale that exacerbates the hazard. This is because the higher the speed, the higher the crash severity (United Nations Economic Commission for Europe Inland Transport Committee (UNECE), 2010).

Although many factors can influence the choice of speed, as required by Article 13 of the Road Traffic Convention 1968, the driver must always be in control of his vehicle and must always be in a position to perform all maneuvers required of him. Factors affecting the choice of speed can be categorized under two headings: external factors and driver-related factors. However, leaving aside psychological or subjective factors that may intervene, such as personal fears and the fear of being late, the choice of the appropriate speed depends mainly on the driver's perception. To determine the appropriate speed, the driver must be in a position to estimate the speed (UNECE, 2010).

The effects of speed; there are a number of important impacts of excessive or inappropriate speed that require careful consideration. Very high speeds have major negative impacts, particularly in terms of road accidents and the resulting deaths, injuries and property damage. They also lead to significant increases in noise and exhaust emissions.

### ***Speed cameras***

Various types of speed monitoring cameras are used: fixed, mobile and variable speed. The fixed speed camera was the first version of the speed detector and was manufactured in London in 1992. Mobile and variable speed cameras are prototype speed detection cameras that have become prominent in recent years. Mobile speed cameras are automatic and have the flexibility to be placed in different locations. However, manpower is required to activate them. Variable speed cameras apply a speed limit by measuring the average speed between two points on the road to reduce excessive speed (Tang, 2017).

A speed enforcement camera is also called a traffic enforcement camera or traffic radar. They are available in roadside, car-mounted or hand-held automatic versions. The task of the cameras is to identify vehicles exceeding the speed limit (Wilson et al., 2010).

Speed monitoring cameras record a digital image of the vehicle if it exceeds the legal speed limit. This digital image (photo) clearly shows the color, type, make and

registration number of the vehicle. The digital images also contain the following information.

- Date of violation
- Time of violation
- Details of the location of the camera recording the image
- Direction of movement of the violating vehicle
- Speed of the violating vehicle
- The speed limit on the road
- The way the car traveled
- Other safety and security parameters

Under the law, images from speed cameras can be submitted as violation evidence. The recorded images are digitally stored in their original form. These images cannot be modified as the security indicator prevents tampering with the image at any stage. All images are encrypted with relevant information such as location, date and time. The format of the original image forms the basis of the evidence presented in court (Marilley, 2019).

#### ***Installation criteria for a speed camera***

The following criteria must be fulfilled for the installation of speed cameras in an area.

- The length of the site must be between 0.4 and 1.5 km
- There must have been at least 4 fatal or 8 serious injury accidents per kilometer in the area to be installed within 3 years prior to installation
- Must be convenient for unloading and loading cameras
- At least 20 per cent of drivers must have exceeded the speed limit
- There should be no other cost-effective solutions to improve road safety (Report New South Wales Center. 2019).

#### ***Positive aspects of speed cameras***

Although most of the positive effects of speed cameras are anecdotal, there is no denying that the awareness of the possibility of cameras at any speed following a given road affects the mood of many drivers. So much so that inattentive drivers have to think twice before speeding, especially in urban areas and school zones.

- **Situational adaptation:** When drivers realize that there is a speed camera in a certain area, they try not to exceed the speed limit in that area by acting accordingly.
- **Random uncertainty:** When drivers encounter enough speed cameras, they wonder whether there are enough speed cameras, especially in urban areas and school zones, and drive accordingly (Report New South Wales Center. 2019).

#### ***Negative aspects of speed cameras***

The debate about driving safety and speed cameras is still ongoing. Some organizations believe that cameras are not important, while others point out that they are effective in at least a few areas. Drivers tend to control their speed on roads where they know there are speed cameras in all cases. This is because they can foresee that they may be affected by speeding fines in the future.

- **Slow speeds:** Awareness of the presence of a speed camera may cause some drivers to drive below the posted speed limit, which can pose a risk to road safety.

- Inaccurate measurements: Radar cameras can give incomplete and inaccurate readings, which can lead to incorrect fines.
- Lack of clear evidence of improved safety: Although it is a constitutional right to confront the accused, in the case of these cameras there is no human being to confront him.
- Selective responses: Drivers change their driving behavior in areas where they know they are being monitored by cameras, and this behavior does not always carry over to other areas, especially where the absence of cameras is confirmed. When drivers know where cameras are not present, they are more likely to speed and behave inattentively in these areas (Elite Driving School, 2023).

## **Traffic accidents and their effects**

### ***Traffic accidents***

A traffic accident is an unplanned intersection of one or more vehicles with other vehicles, facilities, animals or objects on a public or private road. In other words, a traffic accident is defined as an event that occurs without prior intention, resulting in death, injury or loss of property caused by vehicles or their loads while moving on a public road (Radi, 2008; Hamoud, 2019).

As can be understood from the previous definitions, the following elements must be present in order to define a traffic accident.

- Element of fault: it is an unintentional action by one or a group of persons due to negligence, imprudence, carelessness or non-compliance with laws, regulations and systems.
- Means element: unfair behavior that results in damage and is caused by the use of vehicles such as automobiles, motorcycles, trailers, etc.
- Public road: the area on which the tortious behavior resulting in damage occurs due to the vehicle's use of a public road (Radi, 2008).
- Loss of life, property or both: Refers to economic, human and health losses resulting from traffic accidents (Ayed, 2012).

### ***Accident types***

- Collision: an accident involving two or more vehicles with each other, animals or other objects on the road.
  - Rollover: the overturning of a car due to speeding, a defect in the mechanics due to lack of regular inspection of the vehicle, a defect in the roads, weather conditions or strong dust-laden winds.
  - Running over: when a vehicle runs over a pedestrian or a living being.
- Furthermore, traffic accidents can be classified as follows according to their consequences.
- Minor accidents: These accidents do not lead to human injuries and do not result in serious or moderate normal damage, but they usually cause loss of time, some pain and disruption of procedures.
  - Moderate accidents: These are accidents that have an economic impact as they cause material losses in public and private funds, represented by damage to vehicles and the things they collide with.

- Serious accidents: These types of accidents cause serious injuries and lead to the deaths of thousands of people every year. They can cause permanent disabilities that prevent people from leading normal lives. This type of accident is the most dangerous type of accident because it has an impact on economic, social and psychological aspects (Sabiha, 2015).

### **Causes of traffic accidents**

The reasons given below constitute the basic elements of traffic accidents.

#### ***Road***

The road factors causing traffic accidents are given below.

- Geometric design of the road, horizontal and vertical bends and road surface, lack of compliance with the permitted speed,
- Engineering defects represented by incorrect design of the road, lack of shoulders and lack of proper planning during the construction of roads,
- Excavations resulting from maintenance works of some private companies that lack traffic safety methods,
- Lighting condition in terms of its adequacy, suitability for the road and its effect on vision (Muhammad, 2003).

#### ***The vehicle***

The vehicle, the most important tool in traffic, provides benefits to humanity in many areas. However, it has harmful effects on the environment, society and people, as well as negative effects in terms of energy consumed. This also has an impact on economic development (Radi, 2008).

Parameters such as the increase in the number of vehicles, vehicle type, efficiency, technical safety and quality are determining factors in the involvement of vehicles in traffic accidents.

#### ***Driver***

There are indicators that show the extent to which the driver causes accidents, including traffic violations. Committing traffic violations such as excessive speed, irregular turning, incorrect overtaking, disobeying traffic lights, irregular stopping, etc. lead to traffic accidents. In addition, driving under the influence of illness, lack of sleep, psychological conditions or driving under the influence of alcohol, drugs and stimulants affects the driver's driving. This situation invites a potential accident (Ben, 2012).

- Lack of experience and training in driving,
- Different aspects of drivers, such as their psychological, physical and mental state,
- Poor driving and bad habits, such as speeding, not obeying the lane, not keeping a proper distance from the vehicle in front of it and not following traffic rules and instructions, are among the factors of traffic accidents caused by drivers.

#### ***Climate conditions***

Drivers are sometimes exposed to weather conditions that cause reduced visibility. Drivers are affected and some vehicles experience problems such as skidding or breakdowns. This often leads to traffic congestion and therefore traffic accidents. Important weather conditions include wind, sandstorms, fog, snow and heavy rain. In

addition, temperature differences caused by the sun or other factors reduce the coefficient of friction and make the road more slippery during the day in summer. In all of these situations, drivers need to be more careful (Ben, 2012).

### ***Pedestrians***

In addition to the fact that pedestrians' incorrect use of roads poses a risk for their safety, they are the most affected by traffic accidents. Pedestrians cause accidents due to reasons such as not obeying pedestrian crossing lanes, gathering at the places where traffic accidents occur and children playing on the roads. Generally, neglect of their families, occupation of pavements by shopkeepers or peddlers force pedestrians to use the road instead of the pavement (Abdul Aziz Al, 1998). In addition, some pedestrians find it difficult to cross bridges and therefore they prefer to use wrong roads by risking their lives instead of a safe road. As a result; it is known that some pedestrians cause traffic accidents due to their lack of awareness of traffic rules or lack of attention and precautions (Muhammad, 2003).

### **Factors affecting traffic accidents in Duhok and the effects of accidents**

The statistics of road accidents in the city of Dohuk show a high level of accidents. The increase in accident rates in Duhok makes it important to identify the causes of these accidents. One of the aims of this research is to focus on the causes of these accidents. In the research conducted, most people point out that the main cause of traffic accidents is ignorance. There are many causes of traffic accidents, especially ignorance, and some of the important ones are given below.

- The individual receives education from his/her family and continues this education in every aspect of his/her life. In this region, it has been observed that traffic culture is not sufficiently acquired both in the family and in educational institutions.
- It has been observed that driver training centers are inadequate in terms of training and training tools.
- It has been observed that there is a lack of curriculum in driver training centers.
- It is known that the institutions or persons issuing driving licenses and conducting exams do not fulfil the requirements of driving principles by being lenient.

The effects of traffic accidents can be divided into three categories in relation to material and human losses.

- **Social impacts:** The family may lose a member or a member of the immediate family, but when this individual is productive and has an important role in society, this is seen as a loss to society. If the individual is the breadwinner of the family, this can lead to family breakdown, disintegration and thus social disruption.
- **Economic impacts:** Material damage, injuries and deaths resulting from traffic accidents have an impact on national economies and are recognized as an obstacle to development in developing countries. This is because accidents that can lead to death or disability harm people, as well as the money spent by the public to treat the injured, as well as public property and facilities.
- **Medical effects:** In addition to physical injuries resulting in disability, accidents also have psychological effects (Sabiha N. 2015).

### **Results and Discussion**



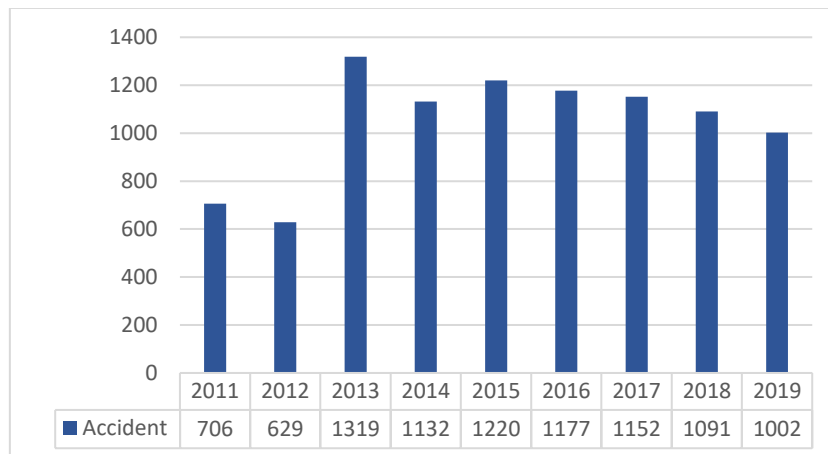
Every year 1.24 million deaths occur in the world as a result of traffic accidents. This shows that the number of deaths as a result of traffic accidents is very high and this number is increasing day by day. It has been determined that about 62% of traffic accidents occur in 10 countries, which account for more than half (56%) of the world's population. India, China, the United States of America, the Russian Federation, Brazil, Iran, Mexico and Indonesia have the highest number of accidents, respectively.

The economic cost of traffic accidents is estimated to be between 1% and 3% of the total national income of countries around the world. In addition, approximately 10% to 15% of the world's hospital beds are occupied by patients injured in road traffic accidents.

According to traffic accident indicators in the Arab world, more than 500,000 traffic accidents occur annually, killing more than 30,000 people and injuring more than 250,000. In addition, road accidents in the Arab world cause about 65 billion dollars in material losses annually, much more than the amount spent on development projects in developing countries.

According to data on road accidents in Iraq, more than 10,753 accidents occurred in 2019, injuring more than 11,651 people and killing around 2,636 people. Indicators for road accidents in the Kurdistan region show that 4,400 accidents occurred in 2019, resulting in 6,080 injuries and 575 fatalities.

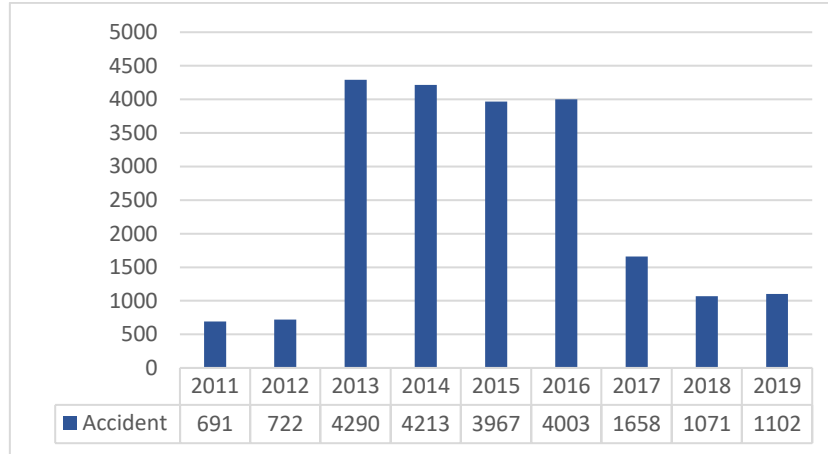
The number of traffic accidents in Duhok province between 2011-2019 is given in Figure 1.



**Figure 1.** Number of traffic accidents in Dohuk between 2011 and 2019.

Figure 1 shows that a total of 9428 traffic accidents occurred in Dohuk in 9 years between 2011-2019. When Figure 2 is examined, the highest number of accidents with 1319 accidents occurred in 2013 and the lowest number of accidents with 629 accidents occurred in 2012. The average number of accidents per year was 1047.5 and the average number of accidents per day was approximately 2.9. In addition, the number of accidents increased from 706 in 2011 to 1002 in 2019, indicating an average annual increase of 4% in accident rates.

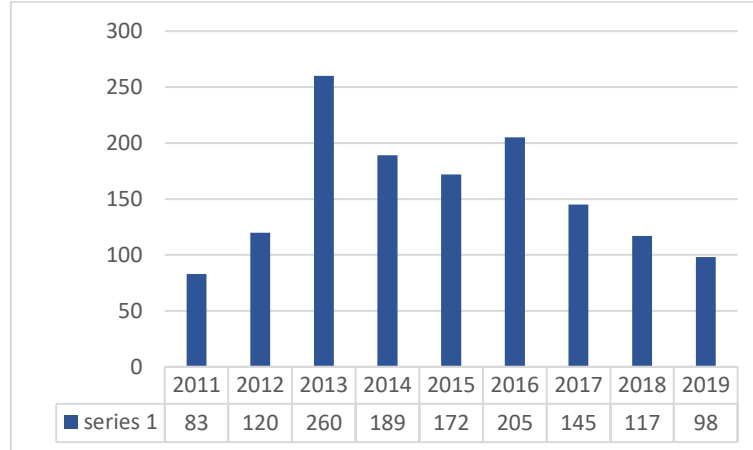
Figure 2 shows the number of people injured in traffic accidents in Dohuk province between 2011 and 2019.



**Figure 2.** Number of injured people in traffic accidents in Dohuk between 2011-2019.

When Figure 2 is examined, it is seen that a total of 21717 people were injured in traffic accidents in Duhok province between 2011 and 2019, and this number increased by an average of 5.32% annually. This means that an average of 2413 people is injured annually and an average of 6.61 people are injured daily in traffic accidents. Furthermore, it is observed that the least number of injuries in traffic accidents occurred in 2011 (691) and the highest number of injuries occurred in 2013 (4290), and the annual average number of injured was over 4000 in the 4 years between 2013-2016.

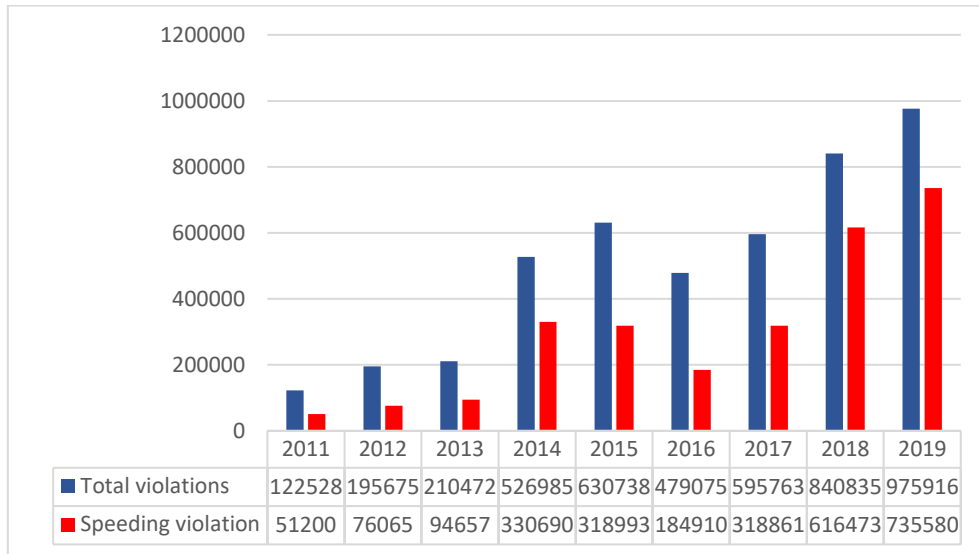
Figure 3 shows the number of people killed in traffic accidents in Dohuk province between 2011 and 2019.



**Figure 3.** Number of people killed in traffic accidents in Dohuk between 2011 and 2019.

When Figure 3 is examined, it is seen that a total of 1389 people lost their lives in traffic accidents in Dohuk province between 2011 and 2019, which corresponds to an average annual increase of 1.86%. This shows that an average of 154.3 people per year and 0.42 people per day lost their lives in traffic accidents. In addition, it is seen that the least number of deaths in traffic accidents occurred in 2011 (83) and the highest number of deaths occurred in 2013 (260), and the death rates were very high in the 4 years between 2013-2016 and the average annual number of deaths for these years was over 200.

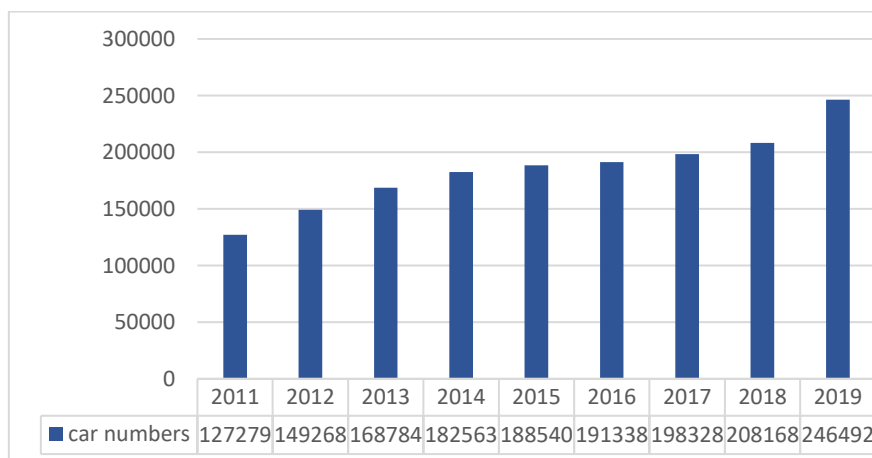
Figure 4 shows the total number of traffic violations and the number of speed-related violations in Duhok province between 2011 and 2019.



**Figure 4.** Total traffic and speed violations in Dohuk between 2011 and 2019.

When Figure 4 is examined, it is seen that the highest number of traffic violations in Duhok province between 2011 and 2019 was recorded in 2019 with 975916 violations, of which 75.37% (735580) were speeding violations. It was determined that the lowest violation was committed in 2011 with 122528 violations, of which approximately 41.79% (51200) was speed-related. In this 9-year period, while the average annual violation increased by 25.93%, speed-related violations increased by 34.46%. In addition, an annual average of 303048 speed-related violations and a daily average of 830.27 speed-related violations were recorded. While the ratio of speed violations to total violations was around 40% in the early years, this ratio has increased to more than 70% in recent years, even reaching 75.37% in 2019. This increase is due to the increase in the number of speed control cameras from 12 in 2013 to 78 in 2014.

Figure 5 shows the number of vehicles registered with the Traffic Directorate in Duhok province between 2011 and 2019.



**Figure 5.** Number of vehicles registered to Duhok Traffic Directorate between 2011 and 2019.

When Figure 3 is examined, it is seen that 127279 vehicles were registered in Duhok province in 2011 according to the data of Duhok Traffic Directorate, and this number increased to 246492 in 2019 with an average annual increase of 7.62%. This shows that an average of 14000 new vehicles were registered in Duhok compared to the previous year. Although there are differences between the rates of increase over the years, it is determined that this increase is in a regular manner.

Table 1 shows the total number of vehicles, the number of speed violations and the number of traffic accidents in Dohuk province between 2011 and 2019.

**Table 1.** Number of traffic accidents in Dohuk between 2011 and 2019

Number of speeding violations	Number of vehicles	The number of accidents	years
51200	127279	706	2011
76065	149268	629	2012
94657	168784	1319	2013
330690	182563	1132	2014
318993	188540	1220	2015
184910	191338	1177	2016
318861	198328	1152	2017
616473	208168	1091	2018
735580	246492	1002	2019

When Table 1 is examined, it is seen that the increase in the number of vehicles and in the speed, violations have a direct impact on the increase in traffic accidents. When traffic accidents are compared in terms of the number of vehicles and speed violations, it is determined that the number of accidents increased from 706 in 2011 to 1002 in 2019 with an average annual increase of 4%, while the number of vehicles increased from 127279 to 246492 with an average annual increase of 7.62% and the number of speed violations increased from 51200 to 735580 with an average annual increase of 34.46%. It is seen that both the annual average increase in the number of vehicles and the annual average increase in the number of speed violations are higher than the annual average increase in the number of accidents. In particular, despite the high increase in the number of speed violations, the increase in the average number of accidents per year remains low, and this is due to the fact that the Duhok Traffic Directorate has placed speed control cameras in areas where accidents are constantly occurring. The number of traffic accidents decreased from 1319 in 2013 to 1002 in 2019, despite the increase in the number of vehicles registered with the Duhok Traffic Directorate and the increase in speed violations at these points.

The causes of traffic accidents in Dohuk between 2011 and 2019 are categorized into two groups as speeding and others and the results are given in Table2.

According to the traffic accident statistics of Duhok Traffic Directorate, the accident rates are high and the reasons for the increase in the accident rates in Duhok province have also been brought to the agenda. When these reasons are identified, necessary measures can be taken to reduce these accidents. When Table 2 is analyzed, it is seen that 52.95% of the traffic accidents that occurred in these 9 years were caused by speeding and the remaining 47.05% were caused by other reasons. While there was a general increase in the number of traffic accidents due to other causes after 2011, the

number of speed-related traffic accidents increased from 428 in 2011 to 900 in 2013 and then gradually decreased to 432 in 2019.

**Table 2.** Causes of traffic accidents in Dohuk between 2011 and 2019

Causes of accidents	Percent	Total	2019	2018	2017	2016	2015	2014	2013	2012	2011
Exceeding speed	%52.95	4992	432	458	563	570	589	648	900	404	428
Other reasons	%47.05	4436	570	633	589	607	631	484	419	225	278
Total	%100	9428	1002	1091	1152	1177	1220	1132	1319	629	706

This is thought to be due to the fact that Duhok Traffic Directorate placed the speed control cameras in the areas where accidents occur. Therefore, it can be concluded that both site selection and the installation of new speed control cameras have an important role in reducing the number of speed-related traffic accidents in the province.

## Conclusion

Traffic accidents are among the major causes of death and disability. The speed at which a vehicle is travelling is the most important factor for death or injury. The faster the vehicle is moving, the more energy the occupants are exposed to during a collision and the greater the degree of injury. If the number of speeding drivers is reduced, it is expected that the probability of accidents and the severity of accidents will decrease. Therefore, measures should be taken to reduce vehicle speed in order to prevent injuries and deaths in traffic accidents. One of the safe speed enforcement methods is the use of speed control cameras and related automatic devices (Wilson, et. al., 2010).

When the statistics obtained from the Traffic Directorate of Duhok province are analyzed, it is revealed that there is an increase in both the number of traffic accidents and the number of deaths and injuries with the increase in speed violations. The possibility of forecasting the indicators of traffic accidents facilitates the selection of appropriate planning processes for the future. Thus, accidents can be reduced and the economic costs associated with traffic accidents in the province can be minimized. The data obtained from the Traffic Directorate of Duhok province were used in the study and the following conclusions were drawn in the light of this information.

- It was determined that an average of 1047.5 accidents occurred annually and the number of accidents increased by 4% annually from 706 in 2011 to 1002 in 2019.
- A total of 21717 people were injured in traffic accidents in Dohuk during this period and 691 people were injured in 2011. These results show that injuries in traffic accidents increased at an average annual rate of 5.32% and an average of 2413 people were injured in traffic accidents per year.
- An average of 154.3 people died in traffic accidents annually and a total of 1389 people died in traffic accidents. Thus, an average annual increase of 1.86% was determined in mortality rates. It was also observed that in the 4 years between 2013 and 2016, the death rates were very high and the annual average number of deaths for these years exceeded 200.
- In 2011, 127279 vehicles were registered in Duhok Traffic Directorate, while in 2019 this number increased to 246492 with an average annual increase of 7.62%. This

shows that an average of 14000 new vehicles was registered in Dohuk in the new year compared to the previous year.

- The highest number of traffic violations in Duhok province was 975916 violations in 2019, of which 75.37% (735580) were speed violations. During the 9-year period, the average annual violation increased by 25.93%, while speed-related violations increased by 34.46%. While the ratio of speed violations to total violations was around 40% at the beginning, this ratio has increased to over 70% in recent years.

- While 52.95% of traffic accidents are caused by speeding, the remaining 47.05% are caused by other causes. The number of traffic accidents caused by other causes has generally increased since 2011. However, the number of traffic accidents caused by speeding increased until 2013 and rose to 900 and gradually decreased from 2013 to 432 in 2019.

Although the number of speed violations and the ratio of speed violations to the total number of violations have increased over the years, the number of accidents, injuries and fatalities has decreased since 2014. This is thought to be due to the 6.5-fold increase in the number of speed control cameras in 2014. Therefore, it can be said that speed control cameras play an important role in reducing speed-related traffic accidents.

### Conflict of Interest

The authors declare that they have no conflict of interest.

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