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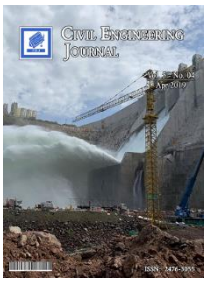

Characteristics of Traffic Accidents in Baghdad

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Abstract

Road traffic accidents (RTAs) are events that suddenly, inadvertently and unexpectedly occur under unforeseen circumstances that involve at least one moving vehicle and result in one or more road users being killed or injured. Unfortunately, Iraqi governorates suffer from higher rates of traffic accident casualties compared with the rates of casualties from terrorist attacks; this situation reveals a serious and growing problem. Road traffic accidents are not easy to eradicate. However, their prevalence can be reduced to the barest minimum via periodic assessments of traffic accident characteristics and the most important aspects for road authorities to consider when designing and evaluating the performance of a road to improve traffic and road users' safety.Therefore, the primary objective of this paper is to evaluate traffic accidents in Baghdad using a retrospective analysis of accidents that occurred from 2006–2016 taking into consideration the following parameters: the cause of the accident, the genders of the victims, the number and type of vehicles involved in the accident, the time of the accident, the severity of the accident, the type of accident and the age group of the driver(s). The data were been obtained from the Central Statistical Organization in the Ministry of Planning. The results reveal that 12,019 RTAs occurred in the city of Baghdad; on average, 1,092 RTAs occurred each year. Twenty-two percent of the RTAs resulted in death, 67% resulted in injury and 6% resulted in both deaths and injuries. Only 4% of the RTAs resulted in property damage without victims. To this end, Baghdad has the highest prevalence of RTAs of all Iraqi governorates. These results provide scientific evidence to mobilize road authorities to effectively and urgently develop adequate traffic strategies and policies to reduce the epidemic of RTAs in Baghdad as well as other Iraqi governorates.

Keywords: Road Traffic Accident; Baghdad; Safety; Fatal; Injury.

1. Introduction

Road traffic accidents (RTAs) pose a global health, economic and social crisis. They are considered to be a very complicated epidemic because they are affected by a collection of factors such as highway design, driver behavior and human factors, speed limits, vehicle functions, and environmental conditions. Globally, according to the World Health Organization (WHO) [1], about 1.25 million people die each year as a result of RTAs. Roughly 85% of these deaths occur in developing countries. Every 4 hours, someone dies and at least three people are injured due to an RTA in Iraq. According to a WHO report issued in 2015, Iraq is ranked 18th out of 180 countries in terms of the total number of RTAs in 2013 (5,789 accidents); India occupies the top rank (137,572). Many countries have assessed the characteristics of traffic accidents to reduce the scale of losses incurred [2].

Based on the availability and type of RTA data, two kinds of research can be discerned in the literature: exploratory and explanatory. Exploratory research refers to, for example, infographics that merely describe the relationships between traffic accident number, mortality or morbidity and influencing factors such as accident type, driver age, time of day,

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day of the week, month, driver gender, weather conditions, road type, vehicle types, etc. Explanatory research serves as a tool for modeling and forecasting the RTAs, mortality or morbidity based on contributory factors using traditional regression models (linear, generalized linear or nonlinear) or some other techniques such as time series models or probabilistic models.

Al-Khateeb [3] conducted a comprehensive study analyzing accident data and exploring the leading causes of RTAs in Jordan. This author found that roughly 67% of accidents in Jordan occurred in the city of Amman (i.e., the capital of Jordan) in 2007. Fatality and injury rates in Jordan decreased from 2000–2005 relatively quickly. Collisions represented about 95% of the total number of accidents (the highest rate of all types of accidents). Al-Khateeb [3] also noted that casualties were more prevalent in summer and that more than 90% of traffic accident fatalities and injuries occurred on roads with speed limits between 40 and 60 km/h. Choueiri [4] analyzed accident patterns in Lebanon to understand accident characteristics and promote traffic safety. This author showed that the victims of road accidents in Beirut were as follows: 48% drivers, 25% pedestrians, 17% front seat passengers and 15% rear seat passengers. Based on the effect of road median geometry on RTAs, the researcher stated that 50% of RTAs occurred on two-way undivided roads and 21% occurred on divided roads. Notably, about 74% of RTAs occurred on clear days and about 25% occurred after dark. Regarding driver profiles, Choueiri [4] found that 54% of drivers involved in RTAs were aged 18–29 years; about 14% were older than 50. Farag et al. [5] performed statistical analyses of traffic accidents that occurred in the road network in Dhofar within the sultanate of Oman. The analysis was carried out using accident frequencies and accident rates. The results revealed a decrease in the total number of accidents during the study time: 2007–2010. The researchers found that collisions were the dominant type of RTAs; collisions account for about 58% of the total number of accidents. Crashes with stationary vehicles accounted for roughly 21% of accidents, and running over an animal accounted for about 9 percent of accidents. Hitting a pedestrian accounted for roughly 3% of accidents. The researchers also showed that about 48% of traffic accidents in Dhofar occurred at intersections; these intersection accidents accounted for roughly one quarter of fatal accident and about half of the injury-causing accidents. Also, Farag et al. [5] found that most accidents occurred during the months of June and July, especially at peak hours (between 11:00 and 12:00 AM). Touahmia [6] examined the main causes of RATs in the province of Hail in Saudi Arabia through the use of questioners. It was found that 67% of RTAs result from human factors, 29% from road conditions and 4% from vehicle defects. Also, the author stated that the excessive speed and violation of traffic rules and regulations were the main causes of RATs. In their study to evaluate road and traffic accidents in Romania, Cioca and Larisa [7] stated that the drivers aged between 26 and 45 are involved in most road accidents. Also, , men were involved in 75% of road accidents, Most of RTAs are caused by low-skilled drivers, with less than six years of driving experience.

There is a dearth of local scientific research in the field of RTAs in Iraq [2]. Al-Jameel [8] developed an expert system for RTAs that provides expert consultation in the domain of highway safety in Iraq. The system consists of two phases. The first one is a diagnostic phase and the second one is a remedial phase. The objective of this expert system was to reduce the number of RTAs. Leidman et al. [9] investigated deaths due to the RTAs from January 2010 through December 2013 in several Iraqi governorates: Baghdad, Al-Anbar, Basrah, Erbil, Kerbala, Maysan, Ninevah, and Al-Sulaimaniya. These authors used RTA data obtained from the Iraqi Ministry of Health (MoH). The results revealed that the peak numbers of road traffic fatalities occurred among males 15–34 years of age and children (under 5 years) of both sexes. The authors also concluded that the RTA fatalities rate ranged from 8.6 to 10.7 per 100,000 people. A recent study by Albayati and Latief [2] analyzed traffic accident data in Iraq from 2005–2015. These authors found that 109,067 accidents occurred during the study period; the largest number of accidents (10,709) occurred in 2013. The researchers stated the run-overs were the worst type of accident, which accounted for 45.7% of accidents. Collisions accounted for 43.3% of accidents. The study also showed that about 61% of RTAs were associated with mortality for 18–47-year age group; the authors furthermore found that males died four times as often as females. Albayati and Latief [2] concluded that 72% of accidents were due to the drivers, 11% were due to the vehicle(s), 7% were due to pedestrians and 6% were due to the roads.

2. Study Area and Data Collection

2.1. Study Area

Baghdad was selected as the study area for several reasons: it is the capital of Iraq and has the largest concentration of urban population in Iraq (2016 population: 7.7 million). Baghdad is experiencing rapid urbanization, economic growth, and motorization (i.e., the number of vehicles per 1000 people). The average motorization level in Iraq has increased from approximately 54 in 2002 to 141 in 2016 [2]; within Baghdad it's about 233, which is considered to be the highest among the Iraqi governorates. This situation has resulted in an increase in traffic congestion and RTAs. Accordingly, it is important to assess the characteristics of RTAs within Baghdad to enable road authorities as well as traffic police directorates to address safety problems. Graphically, the study area is presented in Figure 1.

Figure 1. The study Area, Baghdad

2.2. Data Collection

The data presented here were obtained from the Central Statistical Organization (CSO) in the Ministry of Planning in Iraq and correspond to the period 2006–2016. The collected data include the number of accidents, the number of injuries and deaths, the type of accidents, the severity of the accidents, the type of roads, the causes of the accidents, the time of the accidents and the vehicles type(s) involved. Data pertaining to the ages and genders of the victim were also available. Generally, when a traffic accident occurs traffic police will come to the scene of the accident and prepare an accident report, which includes a diagram of the accident and information about the location, the date and time, weather conditions, the type and license number of the vehicle(s), the gender and age of the people involved in the accident, the cause and type of the accident, the type of road and the number of injuries and/or deaths. A copy of the accident report is stored in a nearby police station.

3. Descriptive Analysis for RTAs in Baghdad City

3.1. Number of Accidents

There were 12,019 RTAs from 2006–2016 in Baghdad; trends related to these accidents and the annual average number of RTAs are presented in Figure 2. The smallest number of RTAs occurred in 2007, coincident with an increase in the price of gasoline (0.375USD per liter) and an unsafe environment in Baghdad in terms of terrorist operations (e.g., car and roadside bombings). This situation resulted in a remarkable reduction in the number of daily trips for people and therefore a reduced probability of RTAs. From 2007–2010, the number of RTAs rose steeply before leveling off and remaining constant in 2011 before peaking at 1,750 in 2012. This increase may be attributed to the increase in average annual income for people in Baghdad. In 2012, the Gross Domestic Product (GDP) reached 6,619 USD per person compared with 3,125USD per person in 2007. Paired with improvements in security, these two reasons likely contributed to a large extent to increasing the car ownership rate as well as the number of daily trips for residences in Baghdad (i.e., the probability of exposure to RTAs steadily increased). It is worth mentioning that the years following 2012 were characterized by a gradual decrease in RTAs. This situation may be due to the series of governmental measures focused on addressing the problem of increasing RTAs within the highway network in Baghdad. One of them, the "even and odd policy," was adopted to reduce congestion on the highway network during peak hours: vehicles with license plates ending with an even number are allowed to drive on even calendar days; vehicles with license plates ending with an odd plate number can drive on odd calendar days. Another governmental measure was limiting driving to those drivers who had a driver's license. This measure prevented teenagers as well as other unauthorized persons from driving.

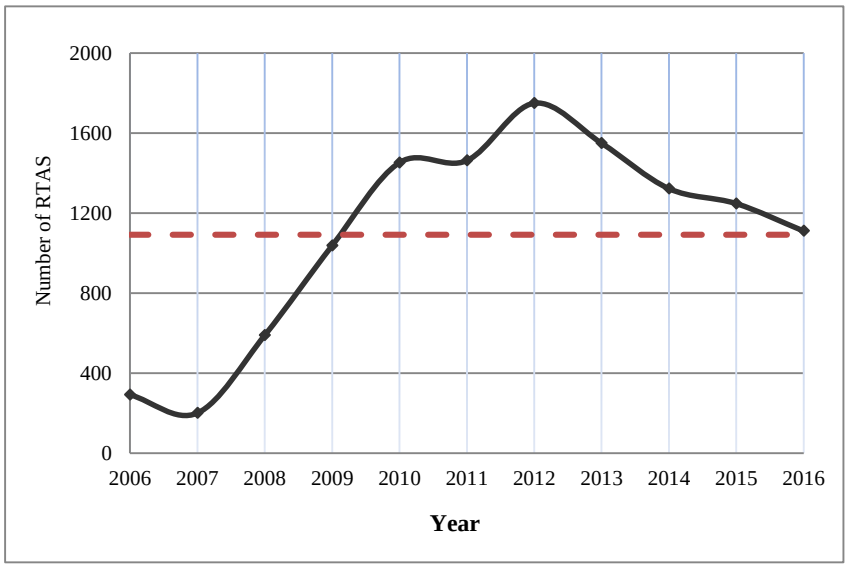

Figure 2. Annual Distribution of RTAs in Baghdad

3.2. Accident Types

Figure 3 shows the rates of different types of accidents in Baghdad during the study period (2006–2016). It is obvious that the most common type of RTA is run-overs, which accounted for about 53% of the total number of RTAs. The second most common type of RTAs was collisions, which accounted for approximately 39% of RTAs. Turnovers constituted about 7% of RTAs. Moreover, 1% of RTAs were recorded as "others," which denoted an RTA such as a vehicle fire or a vehicle falling down a hill into a river. To best understand the level of danger associated with each type of RTA, data were collected about the fatality rate (the number of fatalities per accident) for each type of RTA noted above; the findings are shown in Figure 4. Considering the results shown in Figures 3 and 4, it seems that the most common type of RTA is the most dangerous one (i.e., a fatality rate of 43%). The highest fatality rate for the run-over accident type is attributed to the direct contact between the vehicle and the pedestrian involved in the accident. This finding is alarming and something that the Traffic Police Department must consider when planning new strategies in Baghdad to improve traffic safety. The second most dangerous accident was the turnover accident (i.e., the overturning of a vehicle). This type of accident was associated with a 25% fatality rate. A collision, which occurred when a vehicle collided with another vehicle, was associated with a fatality rate of 12%; the "other" accident type yielded a 2% fatality rate.

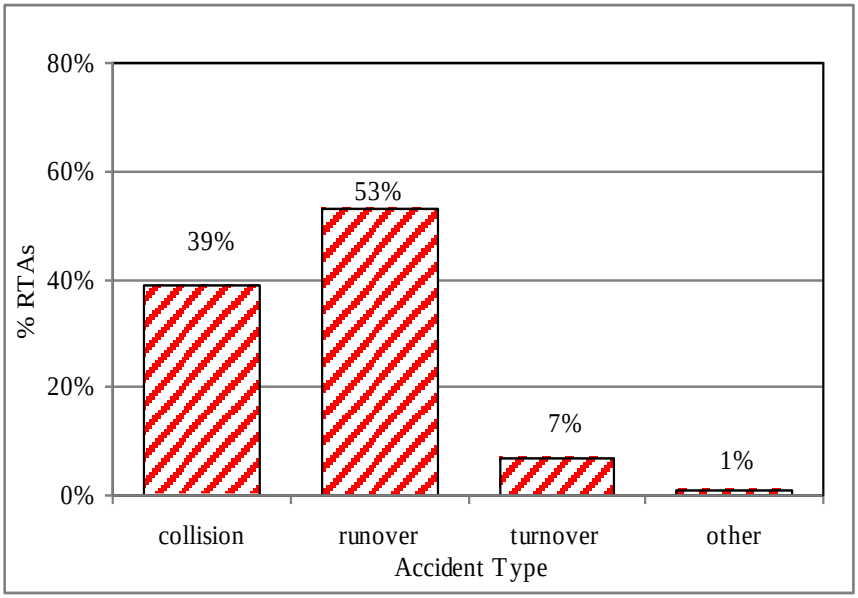

Figure 3. RTAs Distribution by Type

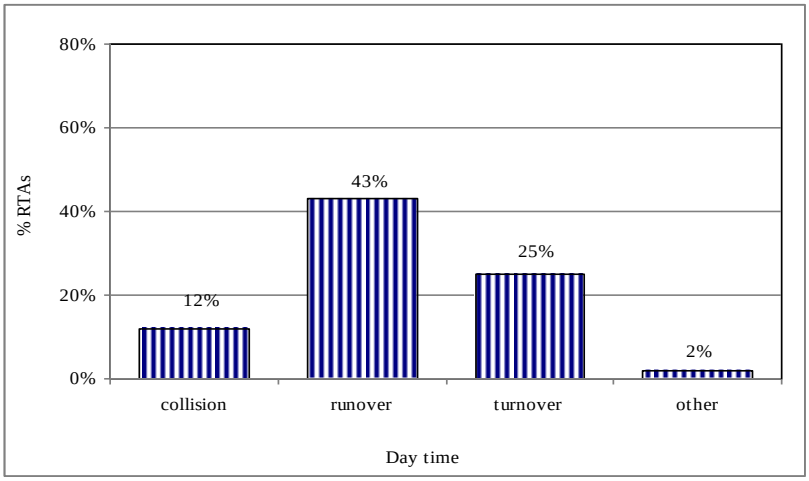

Figure 4. Fatality Rate for the RTA Types

3.3. Severity of Accidents

The severity of accidents can be subdivided into four groups: fatal (at least one victim lost their life), injury (either light injuries or serious injuries), fatal and injury (including both types noted above) and finally "no victim" (no fatalities or injured victims). Among the 12,019 RTAs that occurred from 2006–2016, 22% of RTAs were recorded as fatal accidents and 67% were recoded as injury accidents, as shown in Figure 5. The worst type of RTAs, which is fatal and injury, accounted for 6% of accidents. Four percent of RTAs were of the "no victim" type.

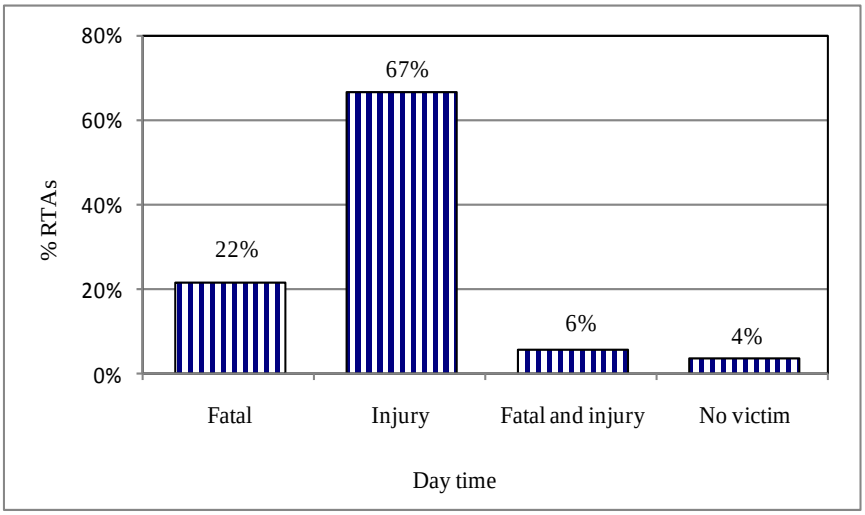

Figure 5. Severity of the RTAs

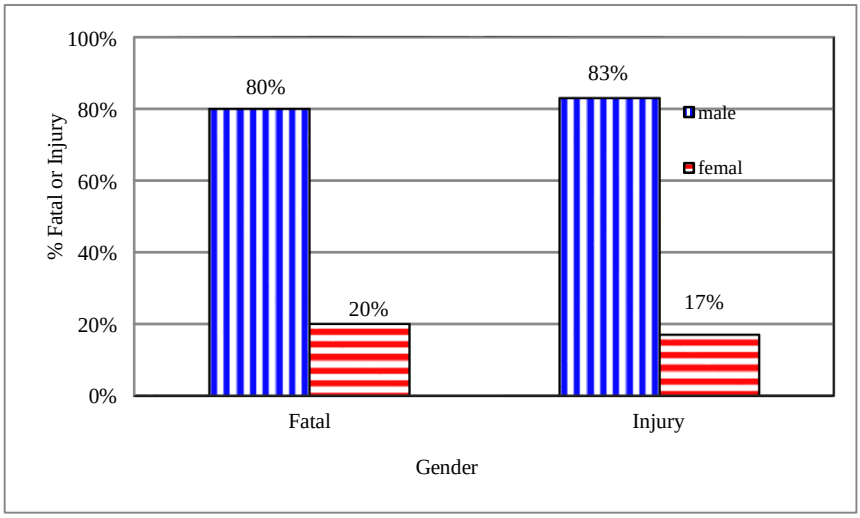

Figure 6. RTAs Victims by Gender

According to Figure 6, which shows the genders of victims for fatal as well as injury type RTAs, it is obvious that the fatality rate of males was four times that of females. For the injury type of RTAs, males suffered approximately79.5% more frequently than females. This finding reflects that males are more apt to engage in risky driving behaviors (e.g., driving aggressively) than females. Another possible explanation for the above results is the proportion of male drivers, which is much higher than that of female drivers in Iraq. Therefore, males are more likely to be involved in RTAs than females.

3.4. RTAs Based on Driver Age

The distribution of RTAs in Baghdad based on drivers' ages is shown in Figure **7**. It is evident from the data that the RTA distribution is skewed towards the younger age group (i.e., a mean age of 27). Twenty-seven percent of RTAs are associated with the age group of 24-29 years. The age group of 30-35 years is associated with 22% of RTAs, and the 18–23-year age group is responsible for 20% of RTAs. Collectively, these three age groups were involved in roughly two thirds of the total number of RTAs during the period 2006–2016. This result can be attributed to the fact that the drivers within these age groups are young adults, active and have more tendencies to make car trips for educational, work and social purposes than drivers in other age groups. As a result, this group is exposed to a higher likelihood of RTAs. Teenage drivers (younger than 17) account for only 5% of RTAs because the drivers within this age group are not permitted to have a driver's license according to local rules stating that the minimum age for obtaining a driver's license is 18 years. Elderly drivers (older than 60) are responsible for only 1% of RTAs due to the limited number of trips that individuals in this age group make.

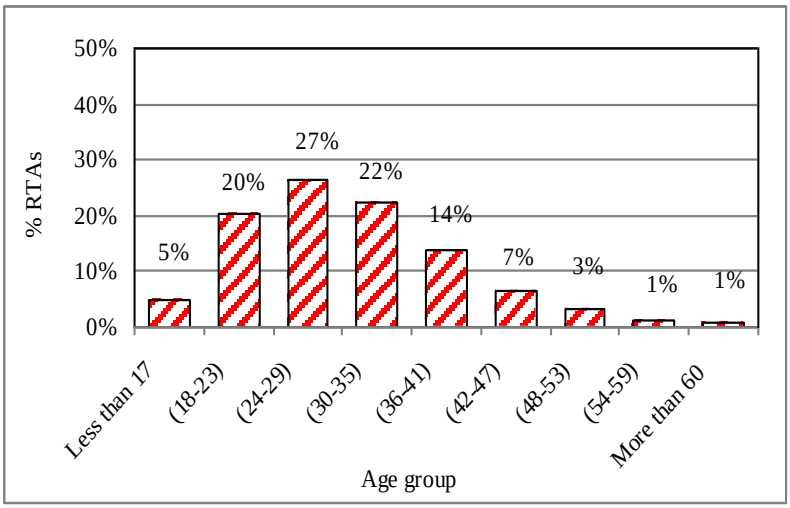

Figure 7. Distribution of RTAs Based on Driver Age

3.5. RTAs Based on Causal Factors

Figure 8 shows the percentage of accidents based on causal factors during the period 2006–2016 in Baghdad. The causes of accidents can be divided into six primary classes: drivers, the road, the vehicle, pedestrians, passengers and others (e.g., animals or obstructions). The largest contribution to the occurrence of accidents is drivers, who account for 64% of accidents. This finding may be attributed to the one of the following factors: non-compliance with laws and traffic safety regulations, exceeding the posted speed limit, driving under the influence of drugs or alcohol. For instance, although the local regulations state that the speed limit for an urban road is 60 km/hr, this limit is enforced only about 30% [1]. The same matters are also applicable to helmet use for motorcycle drivers and seat belt use for vehicle drivers—the enforcement levels are only about 20% and 50% for these matters. The second most highly ranked causal factor for RTAs is the vehicle, which accounts for 17% of accidents. A lack of regular maintenance for vehicles may lead to sudden defects in a vehicle's braking system; defective front or rear lights can also contribute to RTAs in Baghdad. Poor highway structural conditions in some sections of the roadway network (e.g., the presence of severe rutting, which can cause a loss of steering control) and the existence of improper geometric design (e.g., the existence of sharps curves or the absence of some of advance warning or order traffic signs) are responsible for ranking roads third at 8% in terms of causing RTAs. Pedestrians crossing in undesignated crossing lanes over highways rather than using crossing lines or footbridges results in about 7% of RTAs. The remaining causes for RTAs consist of passengers and "other factors," each of them constituting about 2% of RTAs (i.e., the lowest involvement rate compared with other causes).

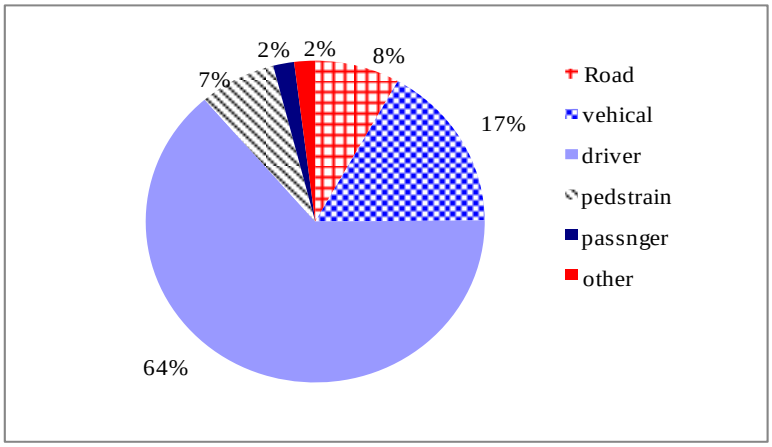

Figure 8. Distribution of RTAs based on Causal Factors

3.6. RTAs Based on Light Conditions

Lighting conditions have an important effect on RTAs. Figure 9 shows the percentage of RTAs that occur during the four lighting conditions of the day for the period 2006–2016 in Baghdad. The highest percentage of traffic accidents occurred during daylight conditions (62%). This finding may be attributed to the fact that the most people work and therefore commute during the day, resulting in a large number of trips on the road network. It is also evident from Figure9 that 14% of RTA occur at night, which may be considered relatively low given the associated visibility restrictions during darkness. However, fewer cars are on the road during the night as well. The incidence of RTAs during sunset (22%) is higher than that during sunrise (2%) due to the high traffic volume that exists on Baghdad road networks in the evening compared with the early morning. Therefore the probability of RTAs is higher during sunset as opposed to dawn.

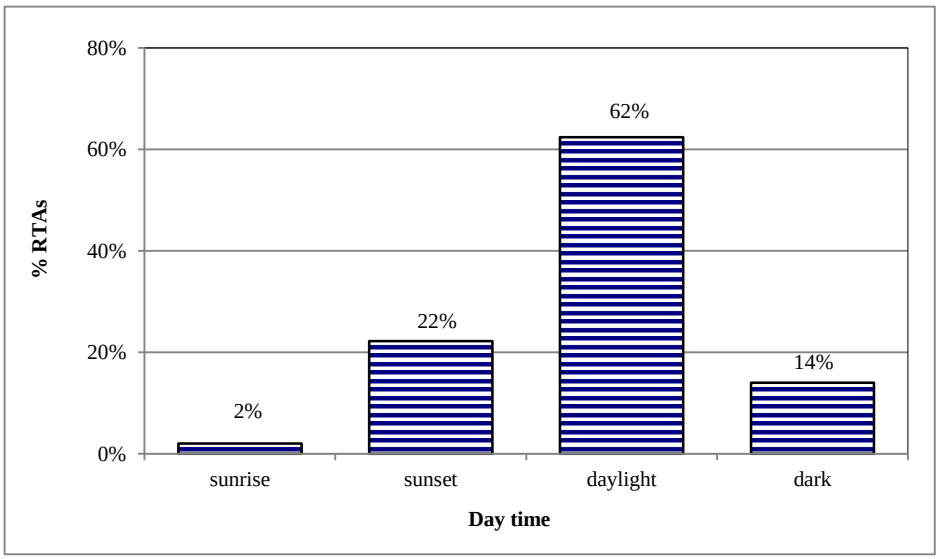

Figure 9. Distribution of RTAs based on Causal Factors

3.7. Monthly Distribution of RTAs

The monthly distribution of RTAs is shown in Figure 10. It is evident that the month of January was associated with the lowest rate of RTAs; it contributed roughly 8% of a year's total RTAs. On the other hand, the frequency of RTAs peaked at 11% in October. This finding may be attributed to additional trips associated with the beginning of the academic year. It is worth noting that the number of RTAs fluctuates slightly during the first two thirds of the year as compared with the last third of the year, which exhibits a detectable fluctuation in RTAs. The average number of RTAs during the last four months of the year constituted 10% of the year's total compared with roughly 9% for the first eight months.

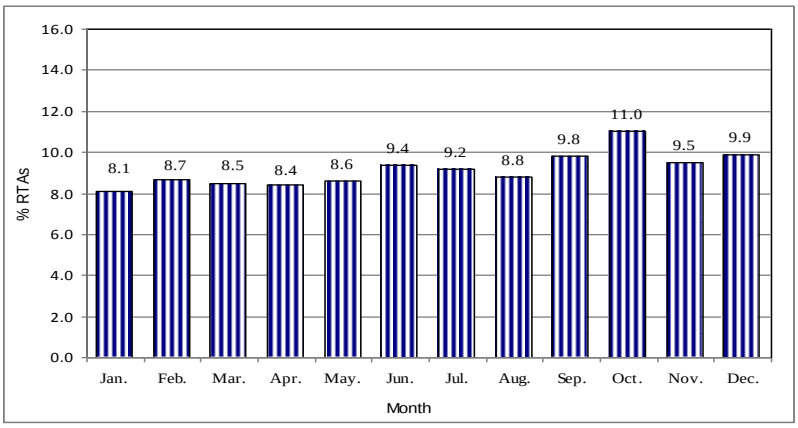

Figure 10. Monthly Distribution of RTAs

A visual inspection of RTA variations on a monthly basis may be insufficient to conclude whether these variations are statistically significant. Poisson mean analysis was conducted using Minitab V16 software. For $\alpha = 0.05$, the results are shown in Figure 11. It is obvious that the average number of RTAs in a month is about 1,100. The Lower Decision Limit (LDL) and Upper Decision Limit (UDL) are 1,009 and 1,191, respectively. There were no significant differences in the number of RTAs as a function of months; all fell between within the limits of decision. The exception was January and October: the former fell below the LDL (indicating the month with the minimum number of RTAs), and the latter fell above the UDL (indicating the month with the maximum number of RTAs).

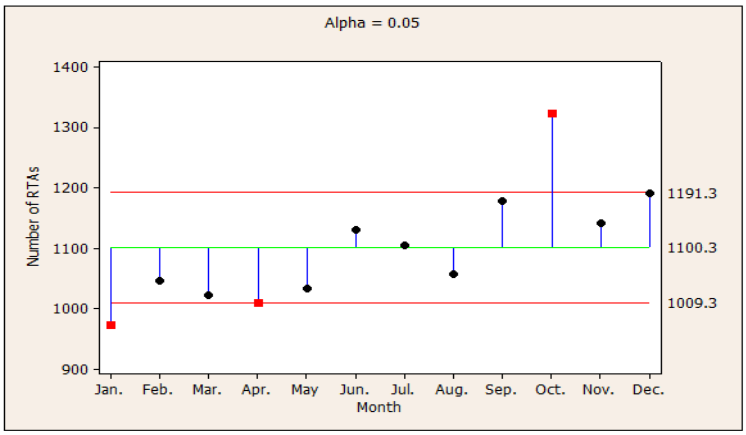

Figure 11. The Variations of the Number of Accidents for the Months of the Year

3.8. RTAs Based on Vehicle Type

Figure 12 shows the participation rates of different vehicle types in RTAs for the study period (2006–2016) in Baghdad. Passenger cars, the primary type of transportation in Baghdad, were involved in 64% of all RTAs that occurred during the study period. Buses were involved in 13% of RTAs; buses are mainly used for short public trips in the network and also for tourism. Trucks were involved in 7% of RTAs, and motorcycles were involved in 4%. Other vehicle types (e.g., agricultural or construction vehicles) were involved in roughly 13% of RTAs.

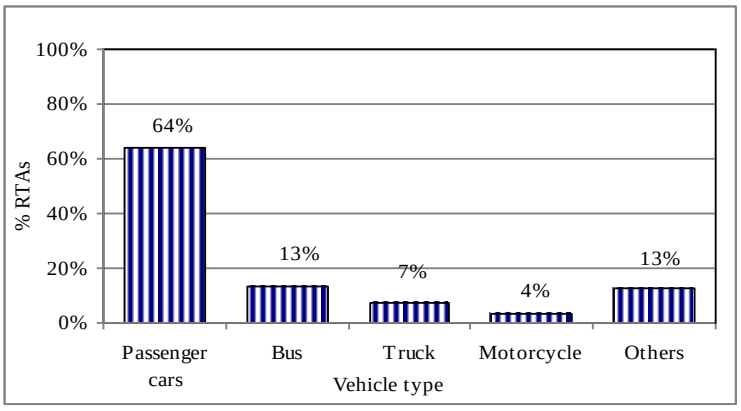

Figure 12. RTAs Distribution by Vehicle Type

3.9. RTAs Based on Highway Functional Class

In Baghdad, the functional highway classification according to the American Association of State Highway and Transportation Officials (AASHTO, 2001) [10] consists of local, collector, minor arterial and principal arterial highways. Each type of road has different traffic circumstances and geometric features. Figure 13 shows the distribution of RTAs based on highway type. The majority of RTAs (53%) occurred on minor arterial roads. This class of highway has a high geometric design characteristic that enables high speed and a high volume of traffic. These aspects increase the probability of an accident; the majority of the transportation network in Baghdad consists of this type of highway. Principal arterial roadway was associated with the second highest rate of RTAs: it accounted for 25%. Some of these types of highways are responsible for linking Baghdad with the rest of the Iraqi provinces; the high traffic volume, combined with the high percentage of trucks that use this type of highway, resulted in a relatively large number of RTAs. Following the arterial highways, the collector highways accounted for 19% of the total number of RTAs. Local roads accounted for 3%. These lower rates of RTAs in comparison with arterial highways may be attributed to the lower speed limits on these types of highways.

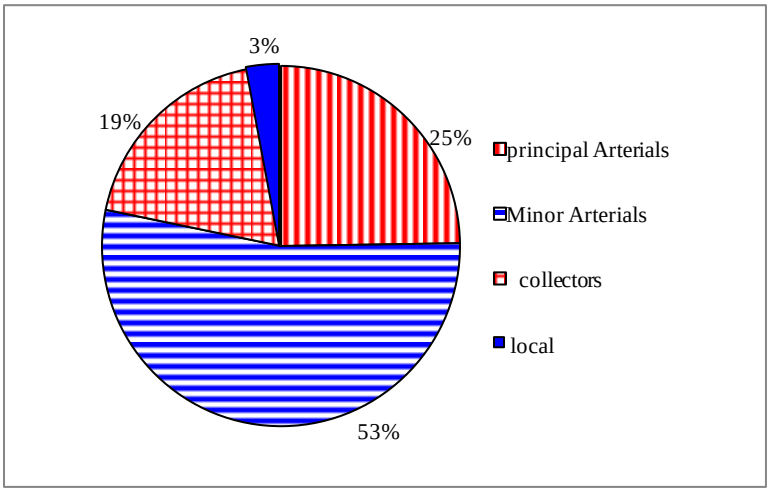

Figure 13. Distribution of RTAs based on Highway Functional Class

4. Conclusions

Based on the RTA data collected for the period 2006–2016, the following primary conclusions can be drawn:

- 12,019 traffic accidents occurred in Baghdad; the annual average number of RTAs was 1,092. The maximum downward and upward divergences from the annual average number of RTAs were recorded in 2007 and 2013, respectively. The corresponding numbers of RTAs during these periods were 201 and 1,750, respectively.
- Among the 12,019 RTAs that occurred during the period 2006–2016, 22% of them were associated with fatalities and 67% were associated with injuries. The RTAs, which include fatal and injury, accounted for 6% of accidents. Four percent of RTAs were of the type "no victim."
- Run over was the most common type of accident during the study period. This type of accident constituted roughly 53% of all RTAs; collisions accounted for 39% of accidents. Turnovers accounted for 7% of RTAs.
- Drivers were the primary cause of RTAs: they accounted for 64% of the total number of RTAs from 2006–2016 in Baghdad. Vehicles accounted for 17% of RTAs. Roads and pedestrians accounted for 8% and 7% of accidents, respectively.
- Males were four times more likely to die in an RTA than females. Males also had a 79.5% higher rate of exposure to injury than females.
- Road traffic accidents are skewed toward involving people in younger age groups; the mean age of people who died or were injured in RTAs was 27. Twenty-seven percent of RTAs were associated with people aged 24–29 years, followed by people in the 30–35 age group (22%), and the 19–23 age group (20%).
- Regarding light conditions, 62% of RTAs occurred during daylight hours. Fourteen percent occurred during the night. Also, 22% and 2% of RTAs occurred during the periods of sunset and sunrise, respectively.
- January exhibited the lowest number of RTAs. On average, this month hosted about 8% of RTAs; the peak number of RTAs occurred in October (i.e., this month hosted, on average, 11% of RTAs).

- 9-Approximately 64% of RTAs were caused by passenger cars, followed by buses. Buses accounted for 13% of the total number of accidents. Trucks were involved in 7% of RTAs. Other vehicle types (e.g., agricultural or construction vehicles) contributed to about 13% of RTAs.
- Road functional class has an important influence on the distribution of RTAs. Roughly 78% of RTAs occurred on arterial roads (53% on minor arterials and 25% on principal arterials). Collector highways accounted for 19% of the total number of RTAs; local roads contributed 3% of the total number of RTAs.

5. Acknowledgements

The authors would like to thank the Consulting Engineering Bureau at University of Baghdad (CEB-UB) for assistance in data acquisition.

6. Conflicts of Interest

The authors declare no conflict of interest.

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