

**Reality of Road Safety Conditions at Critical Locations in Nablus City, Palestine with a Road Map for Future Interventions**

واقع ظروف السلامة المرورية على مواقع حرجة في مدينة نابلس وخارطة طريق للتدخلات المستقبلية

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**Abstract**

Nablus occupies a high level among Palestinian Governorates in terms of traffic crash frequency and rate. The traffic safety system and program in Palestine, including Nablus city is weak and needs much improvement. This research aims to study the reality of traffic safety conditions at selected locations in the city of Nablus and to recommend areas for interventions. Traffic crash data for selected locations in Nablus city was collected based on crash reports from the Police Directorate. The selected locations are critical in the city for their sensitive locations and traffic conditions. Analysis was done for several patterns and traffic/environmental conditions that may have an effect on traffic safety at these sensitive locations. Results show that certain conditions and patterns may contribute to the level of safety. Pedestrians, wet pavement conditions, and night-time crashes were high at certain locations while elderly and females were involved in a limited number of crashes. The practical application of this research is that it forms a road map for traffic crashes and road safety conditions studies and for improving traffic safety conditions in the city of Nablus.

**Keywords:** Road Safety; Traffic Crashes; Safety Planning; Critical Locations; Nablus; Palestine.

**ملخص**

تحتل محافظة نابلس مستوى عال بين المحافظات الفلسطينية من حيث أعداد حوادث المرور ومعدلاتها. يمكن وصف نظام برنامج السلامة المرورية في فلسطين، بما في ذلك مدينة نابلس، بأنه ضعيف ويحتاج الكثير من التحسين. يهدف هذا البحث إلى دراسة واقع ظروف السلامة المرورية في مواقع مختارة في مدينة نابلس، والتوصية في مجالات التدخلات. المواقع المختارة هي مواقع حرجة في المدينة لمواقعها الحساسة وظروف حركة المرور فيها. تم جمع بيانات حوادث المرور لمواقع مختارة في مدينة نابلس على أساس تقارير حوادث السير من مديرية الشرطة في المدينة. تم إجراء تحليل الحوادث لعدة أنماط وظروف بيئية والتي قد يكون لها تأثير على السلامة المرورية في هذه المواقع الحساسة. وتشير النتائج إلى أن ظروف وأنماط معينة يمكن أن تسهم في مستوى السلامة في المدينة. حيث تبين أن حوادث المشاة، وظروف سطح الطريق الرطب، وحوادث السير الليلية عالية في مواقع معينة، ويوجد تكرار واضح لبعض أنواع الحوادث وأسبابها، بينما تشارك الإناث والمسنون بعدد محدود من حوادث السير في المدينة. التطبيق العملي لهذا البحث هو أن هذه النتائج تشكل خارطة طريق لظروف حوادث المرور والسلامة على الطرق وكذلك للأبحاث المستقبلية، وعملية تحسين ظروف السلامة المرورية في مدينة نابلس.

**الكلمات المفتاحية:** السلامة المرورية، حوادث المرور، تخطيط السلامة المرورية، مواقع حرجة، نابلس، فلسطين.

**1. Background**

Current efforts to address road safety are minimal in comparison to this growing human suffering. The world report of Global Status Report of Road Safety indicated that the number of people killed in road traffic crashes is estimated at 1.24 million in 2010; 27% of global road traffic deaths are among pedestrians and cyclists. To date, these road users have been neglected in transport and planning policy (WHO, 2013).

Several reports indicated that Palestine is experiencing an increase in traffic crash frequency, as discussed later. Statistics show that Nablus Governorate has relatively high rate of traffic crashes among Palestinian governorates. On the other hand, traffic safety studies or official interventions are limited in the Palestinian area, including Nablus. The critical cases of traffic safety conditions are not well-known by researchers or decision makers. Therefore, there is a need to conduct traffic safety studies to identify locations with high frequency or rate of crashes and the associated road and traffic conditions.

Nablus Governorate is one of eleven governorates in the West Bank, Palestine. The city of Nablus, which is the main city in the governorate and one of the most important cities in Palestine because of its size and vital geographical location, is the study area. Selected key locations, which are the main corridors or intersections in the city with high traffic volumes, will be the focus of this study (see Figure 1).

The Palestinian Central Bureau of Statistics (PCBS) showed that out of 3675 recorded crashes in the West Bank (WB), 22.4% of traffic crashes occurred in Nablus Governorate in 2008 (PCBS, 2008). In the same year, there were 864 injuries out of which 19 persons died due to these crashes. In 2010, 1727 people were injured and 20 of those were killed due to traffic crashes in Nablus Governorate (PCBS, 2010). Similar crash percentages and fatalities were reported for Nablus Governorate in 2011 (PCBS, 2011); see Table 1.



**Figure (1):** Location of Nablus Governorate in the West Bank, Palestine.  
Source: [https://en.wikipedia.org/wiki/Nablus\\_Governorate](https://en.wikipedia.org/wiki/Nablus_Governorate).

It should be indicated that PCBS reports traffic crashes per governorate with no specifics for particular cities in the governorates. However, according to the Police Directorate in Nablus city, the majority of governorate crashes occur in the city of Nablus.

Approximately one quarter of traffic crashes in the WB occurred in Nablus Governorate, which is high. Therefore, it is concluded that the governorate of Nablus has high occurrence of traffic crashes compared to other governorates of the WB.

**Table (1):** Traffic Crashes and Injuries in the WB Governorates (2009-2011).

Governorate	Crashes			Injuries			Fatalities		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Jenin	508	607	799	809	1044	1101	24	14	9
Tubas	84	102	123	100	140	182	1	7	1
Tulkarm	335	374	453	577	557	575	7	8	11
Nablus	<b>1098</b>	<b>1262</b>	<b>1564</b>	<b>1218</b>	<b>1727</b>	<b>1801</b>	<b>18</b>	<b>20</b>	<b>20</b>
Qalqilya	194	250	341	274	258	431	6	4	5
Salfit	135	146	165	170	254	244	5	1	3
Ramallah	1084	1215	1651	832	837	1107	16	25	14
Jericho	135	120	172	226	246	202	7	3	2
Jerusalem	212	235	316	325	394	389	10	9	11
Bethlehem	332	365	856	437	597	749	3	7	3
Hebron	554	732	966	760	979	1189	28	34	36
<b>Total</b>	<b>4671</b>	<b>5408</b>	<b>7406</b>	<b>5728</b>	<b>7033</b>	<b>7970</b>	<b>125</b>	<b>132</b>	<b>115</b>

Source: PCBS, 2010, 2011, & 2012.

## 2. Objectives

The objectives of this research are

- a. To assess the existing traffic safety conditions in the city of Nablus based on various conditions such as human, road, location, environmental, and traffic.

- b. To conduct comparative traffic safety analysis for selected areas of interests related to traffic safety.
- c. The primary, objective of this study is to pave the ground for future specialized research in various aspects of traffic safety. Therefore, it is envisioned that this will lay out the “*Road Map*” for future traffic safety interventions (research and improvement actions) in the city of Nablus in particular and the Palestinian area in general.

### 3. Study Locations

To date, crash data are stored manually in the Palestinian area. In this research, the needed data were collected through coordination with the Police Directorate in Nablus city. The data were gathered manually for nineteen locations for the past three years; these are 2009, 2010, and 2011<sup>(1)</sup>. The data were taken from the report of each crash, which was stored at the Department of Traffic Crashes.

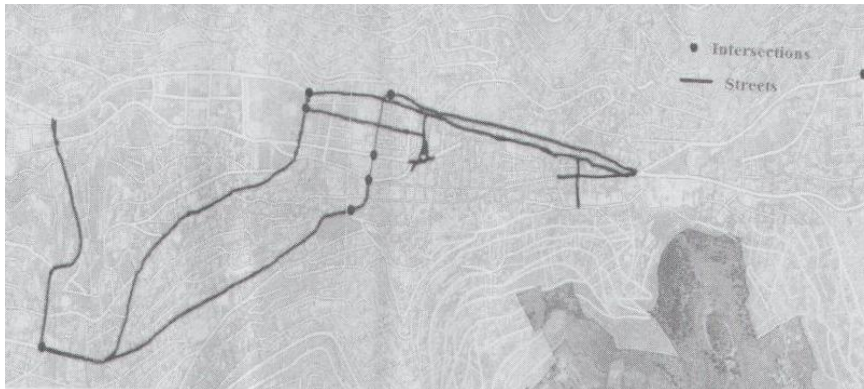
The selected locations include key link sections of the road network known as streets and signalized and non-signalized intersections. Through coordination with the Police Directorate in Nablus city, these locations were identified as strategic in terms of traffic safety conditions. These streets are well-known locally with their high importance in the road network of the city of Nablus. Therefore, their traffic safety conditions are presented in this research. The streets include 3 arterials, 4 collectors, one local, and the central roundabout area in the city center (see Figure 2 for study locations).

The intersections were selected based on their known importance and relatively high traffic volume within the road network of the city. Through visual observations, the level of service at these intersections is critical. These include 7 signalized intersections and two non-signalized intersections.

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(1) It should be noted that this study started in 2012 and lasted for two years.

As shown in Figure 2, the selected locations represent the major streets and intersections in the city that attract different activity traffic (commercial, educational, institutional, recreational, etc.); they simply form the core of the city’s street network. Traffic crashes on the selected locations constituted approximately 28% of the total crashes in the overall of Nablus Governorate, which indicates that these locations are critical in terms of traffic safety conditions.



**Figure (2):** Study Locations in Nablus City.

#### **4. Literature Review**

Palestine is suffering like the rest of the world from traffic crashes daily. Therefore, it is necessary to show the reality of traffic safety in Palestine and compare it with some Arab and non-Arab countries. It is also important to study the situation of traffic safety in Palestine in general and specifically in Nablus city.

##### **4.1 General View on Traffic Safety**

In August 11, 1997 the National Highway Traffic Safety Administration decided that accidents are not crashes. Vehicle crashes and injuries are predictable and preventable events (Garber and Hoel, 2009). Since we can identify the causes of crashes, we can take action to alter the effect, and avoid collisions. Since accidents aren’t crashes, the NHTSA in 1997 initiated to remove the term “accidents” from the NHTSA vocabulary and any media or public NHTSA discussion of

unintentional highway injuries. Instead of accident the use of terms such as crash or collision was encouraged.

Any state is responsible for planning; conducting studies, problem identification, and policy formulations to satisfy safety conditions for road users with follow-up with the implementation bodies. In fact, many developed countries have adopted safety policies and achieved successful stories like Sweden, Japan, United Kingdom, among others. For example, Sweden adopted 'vision zero' in 1997, Netherlands adopted 'sustainable road safety' in 1991, and England adopted 'tomorrow's roads safety for everyone' in 2000. According to the Britain's strategy, a reduction of 50% in the number of children killed or seriously injured should be achieved by 2010, compared with the average for 1994-1998 (Al-Masaeid & Suleiman, 2004).

Bener and Jadaan (1992) found that road traffic fatalities are at the top of the list of major causes of death. The cost of a traffic crash in KSA is 1.7 times greater than that in USA.

It is not always possible to identify the causes of crashes, normally, many factors are involved, and under particular circumstances the result is a crash (Olafsson, & *et al.* 1997). Crash analysis revealed that traffic risk is a function of exposure, probability of involvement, and probable severity. Exposure to vehicular and other conflicts that are susceptible to crash occurrences depends on motorization level, land use, and road planning. There have been several studies relating crashes to these exposure measures (Mittal, 2008; Al-Masaeied & Suleiman, 2004; Brindle, 2001).

## **4.2 Reality of Traffic Safety**

### **Worldwide Perspective**

According to the World Health Organization (WHO, 2010) road traffic injuries caused an estimated 1.24 million deaths worldwide in the year 2010, down from 1.26 million in 2000. The same number of fatalities was reported in 2013 report (WHO, 2013). Half of all road traffic deaths are among pedestrians, cyclists and motorcyclists, and

young adults aged between 15 and 44 years, which account for 59 percent of total deaths. Three out of 4 road deaths are among men. The average rate was 18 per 100,000 people (down from 20.8 in 2000). Ninety two percent occurred in low and middle income countries, with South-East Asia and Africa having the highest rates (WHO, 2013).

According to some research, much of the reduction in traffic fatalities during the last half-century resulted from improvements in emergency response and medical treatment, rather than from traffic safety programs (Noland, 2003). Traffic deaths per kilometer of vehicle travel were five times higher in the United States in 1950 than today (National Safety Council, 2007; NHTSA, 2010). Per capita annual deaths of pedestrians and cyclists in road crashes declined by about two-thirds over the same period, although walking and bicycle trips per household have increased at least since the 1970s (FHWA, 2010). About 262,000 persons suffered incapacitating injuries in traffic crashes in 2008 (NHTSA, 2009). Motor vehicle crashes caused 28 percent of all deaths among young people 1 to 24 years of age in the United States in 2006 (Heron, *et al.* 2009).

Keep (2013) indicates that in 2011, there were 203,950 reported casualties on the roads of Great Britain, including 1901 fatalities and 23,122 serious casualties. In the same year, there was an increase in the number of people killed (3%) and the number of people seriously injured (2%) in road crashes compared with 2010. In 2011, the UK had a lower death rate than all EU member states. The death rate in the United States was around 3 times higher than that in the UK.

Road crash fatality rates (i.e., deaths per 10,000 vehicles) are high in developing countries very often more than 5 times greater than for those countries of Western Europe and North America (Jacob and Sayer, 1983).

### **In Selected Arab Countries**

The problem of traffic crashes in Jordan started to appear as a serious issue in the mid-1980s. In 2007, traffic crashes were considered the second leading cause of death in Jordan. The number of traffic crashes



increased from 15,884 crashes in 1987 to 110,630 crashes in 2007. For the same period, the number of population and the number of vehicles increased only by approximately 2 and 3 folds, respectively. Obviously, this situation was not surprising because Jordan had not yet applied a comprehensive strategy to reduce this problem (Al-Masaeid, 2009). Jordan was ranked fourth in the world in traffic crashes.

The Department of Injuries and Violence Prevention and Disability in WHO (2010) shows every year about 12,000 Egyptians lose their lives as a result of road traffic crashes. Many thousands are non-fatal injury; some with resultant long-term disability.

Al-Ghamdi (1996) indicated that about 8 persons per 10,000 vehicles are killed in traffic crashes in the Kingdom of Saudi Arabia (KSA). Although, KSA has a higher motorization level than some other countries such as Egypt, South Korea, Jordan, Mexico, Brazil, and Venezuela, its fatality rate is yet much lower. The WHO (2004) indicates that in Saudi Arabia, an average of 20 people die every day due to road crashes, which are the primary cause of death in males aged 16 to 36. If current trends continue, Saudi Arabia could have more than 4.0 million traffic accidents a year by 2030 (WHO, 2004).

In Oman, road traffic crashes problem is the number one cause of inpatient deaths and the leading cause of serious injury, disability and premature death among adults (MOTO, 2009). The World Health Organization (WHO) ranked Oman at fourth place in the Arabian Gulf Co-operation Council (GCC) states and 57<sup>th</sup> worldwide as far as the occurrence of traffic crashes and resulting injuries and deaths are concerned (Islam, & *et al.* 2012).

### **In Palestine**

It was noted from statistics of crashes in the West Bank and Gaza Strip that it is still suffering from problematic and limitations in data, lack of accuracy, and the absence of statistical series that allows monitoring of traffic crashes. Some of the observed problems are lack of sufficient information about different age groups, the absence of standardization and classification of traffic crashes, and lack of

commitment by many of the relevant official departments to record accurate information about traffic crashes (Al-Sahili & Abu-Zant, 2003).

In the Palestinian cities, traffic safety practices were neglected for the past 30 years. Since 1995, the Palestinian National Authority (PNA) started taking first steps towards improving road safety. Their achievements in this field were insignificant due to different obstacles. The indicators for the potential increase of vehicle crash frequency in Palestine are roadway users, roadway operators, traffic regulation and enforcement, emergency first aid, administration, and education (Abu-Eisheh & Al-Sahili, 2001).

The number of reported crashes increased from 908 to 5945 from 1970 to 1998 in the Palestinian territories. The fatality rate per 10,000 vehicles reached 14.2 in 1998. Such rate in the Palestinian territories in 1996 was about 4 times that of Israel, but forms about 75.0% of the respective rate of Jordan (Abu-Eisheh & Kobari, 2002). It should be noted that crashes that involve personal injuries are reported, while many of those with property damage only may go unreported and accurate information about those crashes are not known.

Based on a World Bank Study in 2006, the annual rate of increase in the number of crashes and fatalities in the Palestinian territories was about 5.0% in 1994. The percentage of pedestrians involved in the injury crashes was as high as 30% (World Bank, 2006).

Two master theses focused on traffic safety conditions in Nablus city by Kobari, (2000) & Abu Zant, (2001). Kobari built a GIS database for crashes in the city of Nablus for two consecutive years. Analysis of crash records and preliminary hazardous locations had also been identified based on crash records. Abu Zant used the database created by Kobari and conducted detailed analyses of crash frequencies and rates for various locations in the City of Nablus road network. Abu Zant also identified mechanisms for determining the hazardous locations and threshold values for various classes of roadways or intersections.

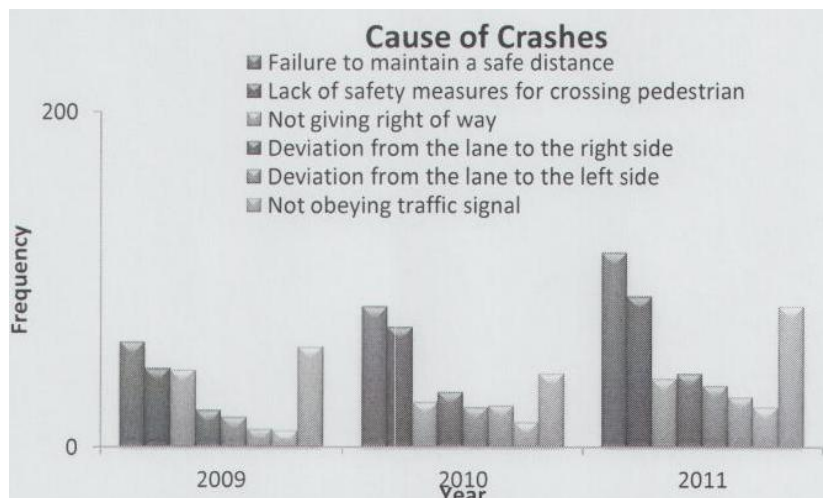
The fatality rate increased sharply in 2003 compared to other years, where it was 16.5 fatality/10000 vehicles. However, the crash data

statistics showed that the fatality rate in the West Bank decreased to 10.1 fatality/10000 vehicles in year 2008 (PCBS, 2009). Based on the PCBS (2010), the total road crashes recorded in the West Bank was 5,408 crashes during the year 2010, out of which there were 7,033 injuries; 84.5% were slight injuries, 11.5% moderate injuries, and 2.1% serious injuries. The fatalities formed 1.9%.

PCBS (2011) reported 7247 crashes in 2011. Ramallah Governorate was the highest (22.0%) followed by Nablus (21.3%), while Tubas has the lowest crash percentage. The number of traffic injuries was 7,769 during 2011, of which 86.6% were slight injuries while moderate and severe injuries formed 11.3% and 2.0%, respectively. Fifty Nine deaths have been recorded at the scene and 45 deaths recorded in hospitals.

Figure (3) shows the relationship between the registered road traffic crashes and injuries in the Palestinian Territory during the period of 2006 and 2011. Traffic crashes and number of injuries increased annually as data shows with a total increase of 45.4% during the period between 2006 and 2011. Nablus Governorate has the highest number of injuries among governorates. Nablus has the second highest number of crashes but was the highest in terms of number of injuries among governorates. Therefore, this is another indicator of the sensitivity and importance of the traffic safety system in Nablus.

In summary, the developed countries have gone a long ways; however, the current traffic safety system in Palestine needs much work and development. There are limited guidance and directions from the official bodies and researchers in this area. There is limited information about where the critical issues are or where the focus should be directed to. Therefore, this research will quantify the traffic safety conditions in a particular and important city in the West Bank, Nablus, as a model to be followed in other Palestinian cities. The research will simply draw a road map of road safety in Nablus City.



**Figure (3):** Registered Traffic Crashes & Injuries in the West Bank (2004 – 2011). *Source: PCBS 2008, 2010 and 2011.*

The PCBS does not report traffic crashes in Gaza Strip since 2006. In addition to the regular traffic crashes, Gaza Strip experiences high rate of crashes caused by motorcycles. There are some reports and studies documenting these statistics in Gaza.

Sarraj (2016) indicated that reported road crashes in the West Bank and Gaza increased by 170% between the years 2007 and 2013, injuries increased by 120%, and deaths increased by 33% for the same period. The author also indicated that traffic crashes in Gaza Strip was 1985 in year 2000 and increased to 4046 in year 2012, then slightly decreased in 2013.

It is reported that traffic crashes have become a major source of concern as the number of deaths is increasing significantly in Gaza. There has been a remarkable rise in the number of victims due to unlawful use of motorcycles and disrespect for rules and laws concerning the speed limit and automobile standards. In 2011, 75 persons have died due to traffic crashes; 36 of them were in motorcycle-related (Al Mezan Center for Human Rights, 2011). The Palestinian Centre for Human Rights (PCHR, 2009) indicated that there are no confirmed figures

regarding the number of motorcycles that entered Gaza via the Egyptian borders; however, these were estimated between 8,000 and 10,000. Some sources indicate that more than 30,000 motorcycles entered Gaza since the beginning of 2008. Traffic police statistics indicated that 883 road crashes were recorded in 2008. Of these, 610 were caused by motorcycles resulting in 20 deaths while 837 others sustained injuries.

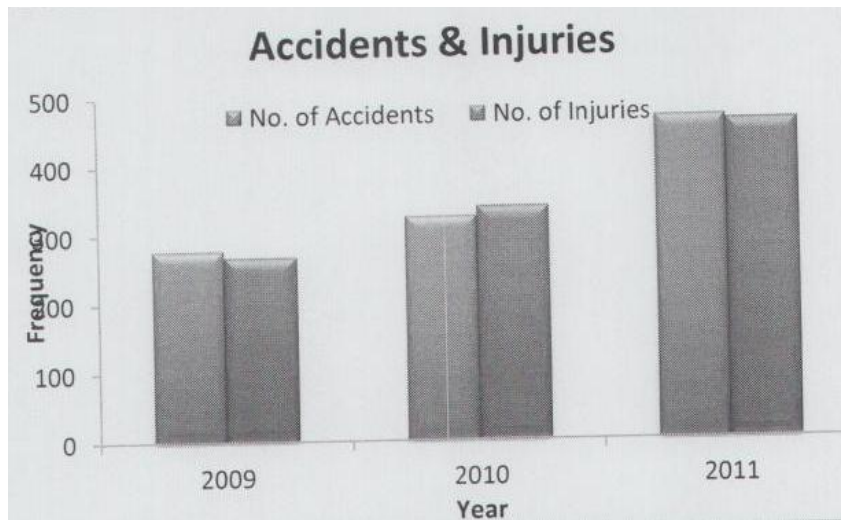
### **5. Data Collection**

Traffic crash records for three years (2009, 2010 & 2011) were collected in collaboration with the Department of Traffic Accidents in the Police Directorate of Nablus Governorate. The data was collected manually as the traffic crash records are not computerized.

Data originated from the crash report is filed in special log book at the police department, which includes details of the traffic crashes at these locations. This information includes, in addition to the basic information: location, weather conditions, lighting conditions, traffic control devices, road surface, injuries, road geometry, and type and cause of crash.

### **6. Analysis of Crashes**

In this research, the focus is on identifying the locations that are candidates for improvement, and to quantify the main crash trend(s) at a particular location and determine the source of the problem(s). Records for 1067 traffic crashes were obtained, among which 277, 324, and 466 crashes were for years 2009, 2010 & 2011, respectively. Records include 1065 injuries distributed yearly as 267, 338, and 460, respectively. In total, 94.1% of injuries were slight and the others varied between medium, severe, and fatal. Figure (4) shows the annual frequency of crashes and injuries for the study period at the selected locations.



**Figure (4):** Crash Frequency and Injuries at Study Locations in Nablus City (2009-2011).

### 6.1 Crash Rates

In this research, the used rate is based on traffic volume for intersections (crashes per million entering vehicles – Crash/MEV) and based on section length for street segments (crash/million vehicle-kilometer – crash/MVK).

The formula for calculating the crash rate for a roadway segment is:

$$R = \frac{A \times 1,000,000}{L \times ADT \times 365}$$

Where:

- R: Rate of crashes per Million Vehicle Kilometers Traveled (MVK).
- A: Average number of crashes along the study roadway per year.
- L: Length of roadway segment in Kilometers.
- V: Average Daily Traffic Volume (ADT) along the roadway.

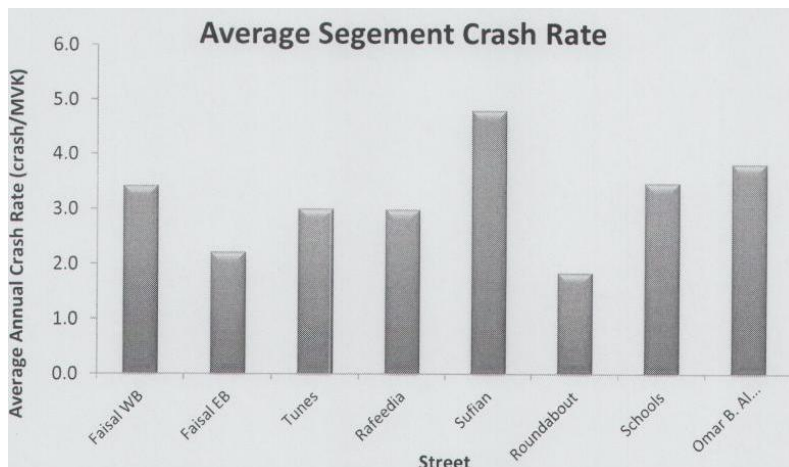
Where the formula for calculating the crash rate at an intersection is presented as:

$$R = \frac{A \times 1,000,000}{ADT \times 365}$$

Where:

- R: Rate of crashes per Million Entering Vehicles (MEV).
- A: Average number of crashes at the study location per year.
- V: Intersection ADT (total daily approach volumes).

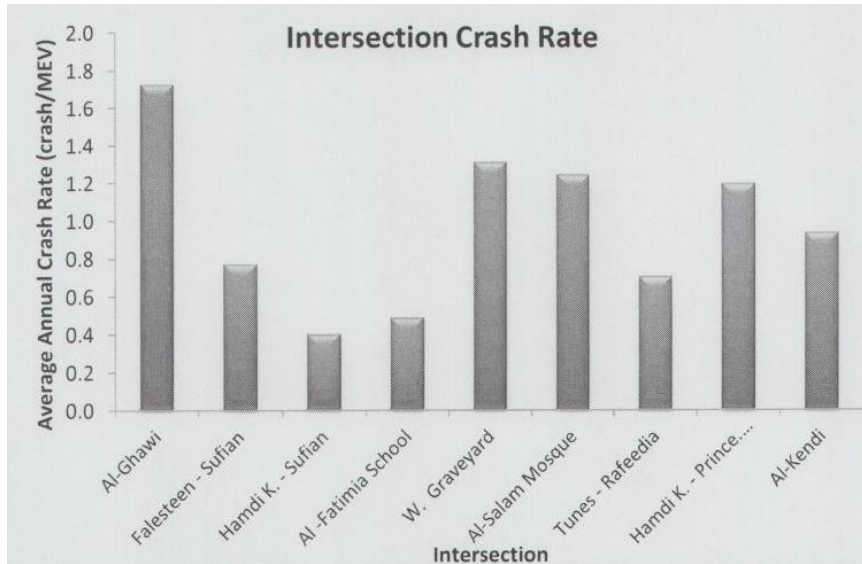
The results of crash rate for streets and intersections are shown in Figures (5 and 6). It should be noted that the city center's roundabout was not considered as an intersection in this study because crashes were recorded for the roundabout area (roundabout and adjacent streets) and not necessarily on the roundabout itself. Therefore, it was included among the study streets rather than intersections.



**Figure (5):** Segments Crash Rate at Selected Locations in Nablus City (2009-2011).

Sufian Street has the highest annual recurrence of traffic collision (4.8 crash/MVK). The street experiences heavy and conflicting traffic

movements most of the day. Drivers generally do not respect the traffic signs/signals and do not give the priority of the road as required. Parking of vehicles on both sides of Sufian Street is another obstacle to achieve traffic safety.



**Figure (6):** Intersection Crash Rate at Selected Locations in Nablus City (2009-2011).

The second location is Omar Bin Al-Khattab Street (3.8 crash/MVK), followed by Faisal Street, which is a major arterial street in the city that experiences the highest traffic volume and has several traffic challenges. Schools Street has a low traffic volume and relatively low crash frequency, while the annual crash rate is approximately 3.5 crash/MVK; pedestrian crashes formed 27.0% of all crashes along this street. Finally, the Roundabout area (city center) is the vital center of the city where pedestrians are continuously and heavily passing. It is necessary to note that while the frequency and rate of crashes is low, about half of them (58.3%) involved pedestrians.

The Intersection of Al-Ghawwi recorded the highest annual crash rate among the study intersections (1.7 crash/MEV) with a rising rate of



crashes by more than 40.0% yearly, showing a steady increase in the number of crashes per year. Earlier studies in the city of Nablus indicated that this intersection was the most hazardous locations in the city of Nablus (Abu-Zant, 2001). It should be noted that 64.0% of crashes at this intersection resulted in injuries.

The second highest location is the Western Cemetery. This is followed by Al-Salam Mosque Intersection (1.2 crash/MEV). Pedestrian movements at this intersection are relatively light (11.0% of the crashes at this intersection involve pedestrians).

## **7.1 Crash Pattern Analysis**

### **Weather Conditions**

Most crashes were in clear weather (94.5%) indicating that weather condition is generally not considered a contributing factor to traffic crashes in the study period.

### **Road Surface**

The vast majority of crashes (97.18%) occurred during dry conditions over the study period, thus indicating that road surface condition is generally not considered a contributing factor to traffic crashes in the city. However, there was a clear increase in percentage of wet conditions crashes on the intersections of Prince Mohammed Street with Hamdi Kan'an and Ahmed Al-Shaka Streets. This may be due the lack of proper rain water drainage that causes accumulation of water in the form of ponds; the street surface remains wet for a long period of time.

### **Lighting Conditions**

All study locations are within the urban boundary of Nablus city where these are lit with street lights. Approximately 22% of all crashes occurred during the nighttime. It is noted that the crash frequency at night-time was almost constant for the first two years, while increased in the last year by approximately 60%; day time crashes significantly increased as well in year 2011. The crash percentage and the lighting

condition at streets are different than those at intersections. There is an increasing trend of crash percentage over the study period during night time at intersections.

More than one-third of crashes on Tunes Street occurred at night; this gives an impression that this street needs investigation of night lighting conditions. Furthermore, 60% of crashes on Schools Street were during night-time, which is also high compared to the other locations. It is also an indication that schools children were not involved in crashes since schools are closed during night-time. One quarter of crashes along Rafeedia Street was during nighttime, this percentage is also high. Pedestrian and vehicles movements are very active during nighttime at this street especially in the summer time.

Crashes on Al-Fatimia School Intersection were split between day and nighttime, which invites researches to study lighting conditions and visibility for drivers and their role in traffic crashes. The second intersection is the Western Graveyard where 28% of its crashes were during night time.

#### **Traffic Control Devices (TCD) Conditions**

It is no surprise that the highest percentage (36%) was at signalized intersections since most of study intersections were signalized. High percentage of crashes (31%) occurred at locations free of TCD. This may indicate that the absence of a TCD may lead to a traffic crash, thus proper traffic control at these locations may be warranted. On the other hand, crashes at locations with no traffic control decreased by approximately 34% during the study period. This may be a random occurrence; thus requires further investigation.

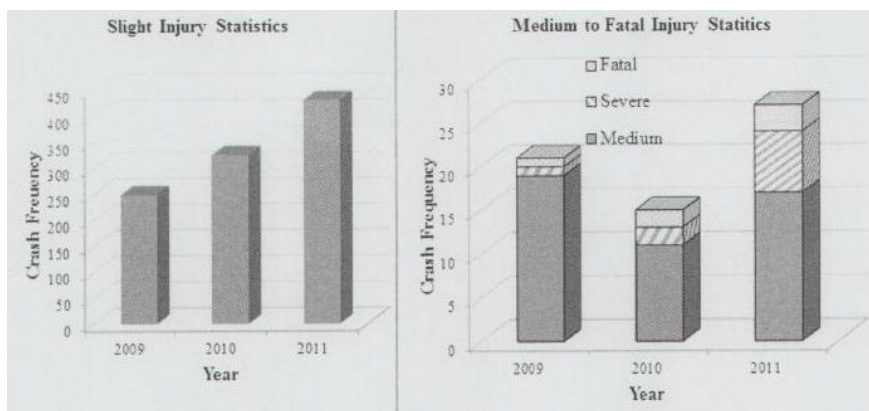
#### **Casualties and Injuries**

On average, 53% of all crashes resulted in property damage only (PDO) and the remaining (47%) caused injuries. The total number of personal injuries reached to 1065 with 94.1% slight injuries (see Figure 7) and six cases of deaths; all of which occurred along streets. Half of the deaths were on Faisal Street, specifically in front of the National

Hospital. Severe injuries slightly increased over the three-year period on streets while moderate injuries decreased annually by approximately 42.0% on streets and 50.0% at intersections.

**Pedestrians Crash**

Pedestrian crashes formed approximately 20.8% of total crashes at the selected locations with a slight annual increase. The highest percentage of pedestrian crashes was at the Martyrs Roundabout in the city center with 69.4% of its total crashes, and formed 11.3% of pedestrian crashes at all study locations. The existing environment at that location may distract drivers while heavy pedestrian traffic cross the streets frequently, irregularly, and at non-designated areas with little caution.



**Figure (7):** Frequency of Injury Types at the Selected Locations in Nablus City.

The next location is Faisal Street segment in front of the National Hospital, which has very heavy pedestrian movement. The percentage of pedestrian crashes on this street was 35% of its total crashes; forming 25% of the overall pedestrian’s crashes for the study locations. The location is controlled by a traffic signal, so it is expected that pedestrian crashes be minimal. Therefore, it is necessary to evaluate this location in order to improve its level of safety conditions.

Rafeedia Street has the highest share of pedestrian crashes for the study locations; it formed approximately 33.3% of the total pedestrian crashes within the selected locations. Pedestrian crashes on Rafeedia Street were 18.7% of its crashes. This street suffers from heavy traffic movements that are conflicting with heavy pedestrian movements as well. A safety evaluation study is necessary at this street with a focus on pedestrians. Furthermore, the percentage of pedestrian crashes on the street in front of the Old Campus of An-Najah National University was approximately 28.0% of its total crashes.

### **Road Geometry Condition**

More than half of all crashes occurred on straight road segments, while 6.8% of crashes occurred at curved roads. Crashes at three-leg and four-leg intersections were approximately equal forming about 20% of the total crashes at study locations. Curved roads may have limited sight distance and may include driving discomfort thus causes a safety hazard. The percentage of traffic crashes on the sloped road was nearly negligible except on Tunes Street.

### **Drivers Age and Gender**

Youth and old drivers may have a high crash risk. Young drivers have a tendency to take risks while driving more than other drivers. Elderly drivers' problem may increase gradually as their share of the population increases. The age group of drivers was divided into five categories as shown in Table 2. The first group is related to teenagers who do not have driver's licenses and their age is less than 17 years.

**Table (2): Crashes and Drivers Age Group.**

<b>Age Group (years)</b>	<b>Percentage (%)</b>
17 or Less	1.03
18-28	30.27
29-40	29.90
41-59	24.09
60 or older	2.62
Not Recorded	12.09

It is noted that the 60% of crashes occurred among drivers whose age group is 18 - 40 years old while this age group constitutes approximately 40% of the total population in the West Bank. On the other hand, only 2.6% of crashes involved elderly drivers (60 years or older), which indicates that there is no apparent safety problem with older drivers.

There was no noted difference in driver's age as related to the place of the crash. It is interesting to note that 18.6% of drivers who were involved in crashes in front of the National Hospital were illegal drivers; less than 17 years old. This is a place with heavy police presence.

For driver's gender, it is clear that crashes often involve males forming approximately 93.4%; females were involved in only 6.6% of all crashes, which is contrary to common perception that females driving may be hazardous. The location with the highest percentage of crashes involving female drivers was at the intersections of Tunes and Rafeedia Streets (23%).

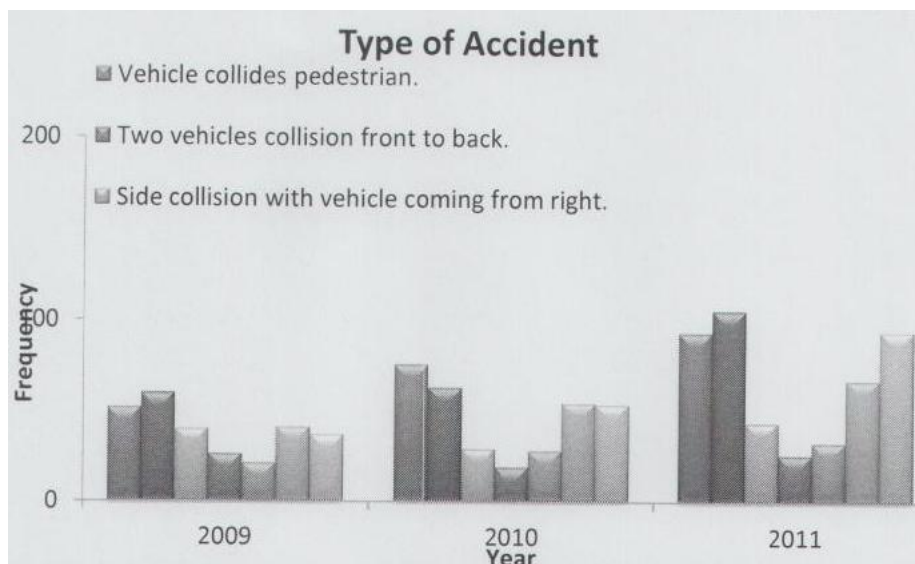
### **Type of Crash**

Based on data collected, twenty one types of crashes were recorded. Analysis shows a high rate of occurrence of certain types. Six types of crashes were the most frequent and should be focused on in future work. Table (3) shows the percentage of crash types.

The first six types of crashes formed approximately 83.0% of the total crashes. Figure (8) shows the percentages of these six main types. In general, there are two main types of crashes with high frequency, which are the rear-end crashes (front-to back collision) and pedestrian crashes, respectively. This shows a serious situation for the safety of pedestrians. In addition, it shows another driving problem, which is failure to maintain a safe distance between vehicles (driving too closely). On the other hand, the majority of intersection crashes were collisions between vehicles coming from left or right (side swipe). This might be due to heavy traffic, narrow lanes, and/or attempts to change lanes at the intersection.

**Table (3):** Crash Type Analysis<sup>(2)</sup>.

Rank	Type of Crash	Percent age (%)
1	Two vehicles collide front to back	21.46
2	Vehicle collides pedestrian	20.81
3	Side collision with vehicle passing in the same direction	15.37
4	Side collision with vehicle coming from right	10.60
5	Front collision with vehicle coming from opposite direction	7.69
6	Side collision with vehicle coming from left	6.65
7	All Other 15 types	17.42



**Figure (8):** Frequency of Crash Types at Selected Locations in Nablus City.

(2) The types of crashes were as recorded in the crash report.

Rear-end collisions had the highest frequency forming 21.5% of all crashes. This type of crash represents approximately one-third of crashes on Faisal Street and 30% of crashes on Rafeedia Street. There are also other locations with high percentages of this type of crash.

The results of crash type analysis for the selected streets were different from those at intersections, especially for pedestrian crashes where approximately 20.8% of street crashes involved pedestrians. At intersections, the percentage of pedestrian crashes on Al-Fatimia School Intersection was approximately one-third of its total crashes, while slightly more than one quarter of crashes on the Western Graveyard Intersection and on Hamdi Kan'an Street and Prince Mohammad Street Intersection. However, there were no pedestrian-type crashes at the intersection of Rafeedia and Tunes Streets.

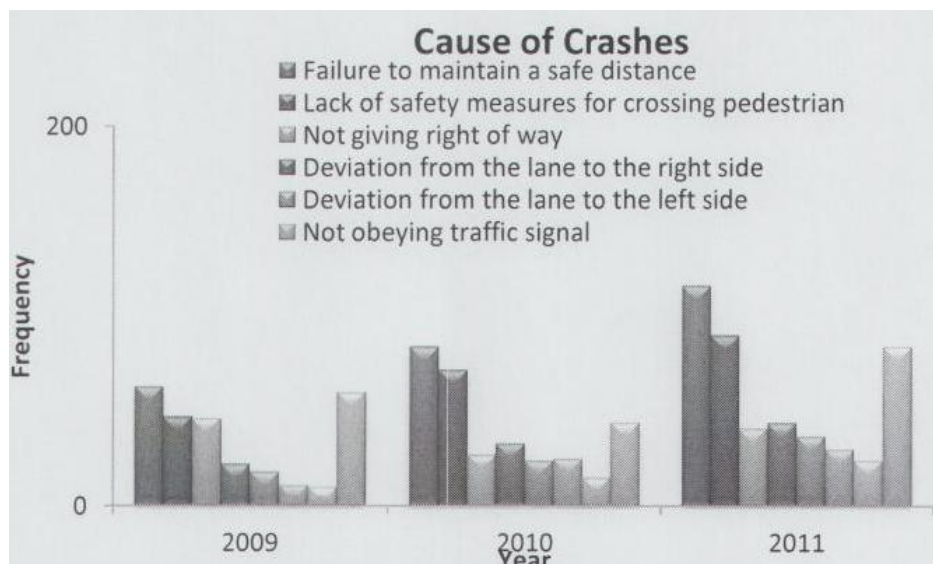
The next type is collision with vehicle coming from right (10.6%). This kind of crash was widespread on most intersections. They constitute high percentages at Sufian Street and Hamdi Kan'an Street Intersection, Rafeedia Street and Tunes Street Intersection, Al-Fatimia School Intersection, the Western Graveyard Intersection, and Al-Kendi Intersection.

### **Cause of Crash**

The crash reports listed twenty seven different causes of traffic crashes. Table (4) shows the highest percentage of crash causes. The first seven causes form more than 82% of all crash causes. Figure (9) shows the frequency of the main crash causes.

**Table (4):** Causes of Crashes <sup>(3)</sup>

Rank	Cause of Crash	Percentage (%)
1	Failure to maintain a safe distance	24.65
2	Lack of safety measures for crossing pedestrian	19.59
3	Not giving right of way	10.70
4	Deviation from the lane to the right side	9.28
5	Deviation from the lane to the left side	7.40
6	Not obeying traffic signal	6.19
7	All Other 15 Causes of Crashes	22.19
7	Not obeying stop sign	4.60
	<b>All Other 20 Causes</b>	<b>17.59</b>



**Figure (9):** Frequency of Crash Causes at Selected Locations in Nablus City.

(3) The causes of crashes were as recorded in the crash report.



The highest cause of crashes was “failure to maintain a safe distance” with a total percentage of 24.7% of all crashes. Faisal Street has the highest rate of crashes due to this cause compared to any other street, which formed 34.7% of its total crashes. This was followed by 27.1%, 26.0%, and 26.2% on Rafidia Street, the Old Campus Street, and the New Campus Street, respectively. Regarding intersections, Al-Salam Mosque Intersection represents the highest percentage of crashes caused by this pattern, where it was 44.4% of its crashes. It is followed by Al-Kendi Intersection, where it formed 32.3% of its crashes.

The second cause of crashes is “failure to give necessary safety measures for pedestrians while crossing the road” forming 19.6% of overall crash causes. The way this cause is stated is very general and may include several other related causes; this may partially explain its high percentage of occurrence reaching approximately two-thirds of crashes on Martyrs Roundabout, and one-third on the National Hospital Street and Schools Street. It also reached 25.6% of crash causes on Sufian Street and 16.2% on Faisal Street.

Furthermore, 20.0% of the crashes on Sufian Street were related to “not giving priority”, which was the highest percentage among the selected streets; this maybe expected because of the high traffic volume on this street most of the day. At intersections, Sufian and Hamdi Kan’an Streets Intersection has the highest percentage of this cause of crash (26.7%). This was followed by the Western Graveyard Intersection (22.2%). Rafeedia and Tunes Streets Intersection was the third rank location as related to this cause of crash.

## **7. Conclusions and Recommendations**

The original objective of this research is to study, analyze, and evaluate traffic safety conditions at selected locations in the city of Nablus during years 2009, 2010, and 2011. However, when started, there was a clear lack of guidance from the Palestinian literature and at the policy level on where to start and what the critical issues are. Therefore, the objective was re-oriented to draw a “road-map” for road safety conditions in Nablus City.

## Conclusions

This study provides a wealth of information about crash frequencies, rates, types, severity, patterns, etc. It simply forms a road map for crash conditions in Nablus city that can be of great benefit for decision makers and researchers to follow up. The study indicates the importance of focusing on some aspects of crashes more than others. The followings are the general conclusions of the study:

- Nablus Governorate has the second highest frequency of traffic crashes in the West Bank and the first in terms of crash injuries.
- Data of traffic crashes is recorded manually in specific files at the Traffic Police Department with some information details. There are some inaccuracies in data recording and interpretation.
- The study investigated traffic crashes in Nablus City for the period of 2009 – 2011 at selected locations covering the major streets and intersections in the city. These locations are known for their high traffic volumes and represent key locations for the traffic movement and circulation in the city. At the selected locations, 1067 crashes were obtained and 1065 injuries resulted. Crashes and injuries have increased yearly during the study period.
- In general, there is no apparent trend of crash due to weather condition, wet surface, driver’s age, or gender in Nablus city.
- Night-time (lighting condition) was found to be a factor affecting traffic crashes on limited streets such as Tunes and Rafeedia Streets, and at limited intersections such as Al-Fatimia School Intersection.
- Crashes during wet conditions were relatively high on limited locations such as at the Intersection of Prince Mohamed Street and Hamdi Kan’an Street.
- The majority of crashes were Property Damage Only (PDO) with limited fatalities (only 0.6%); half of them on Faisal Street.

- Pedestrian crashes form considerable percent of crashes (19.6%) with an increasing rate annually. Martyrs Roundabout, Faisal Street, and Rafeedia Street were the highest among others for pedestrian crashes. Contrary to common perception, there was no pedestrian crash issue on Schools Street.
- Road geometry may have an effect on traffic safety conditions as half of crashes occurred on curved and sloped roadway segments. This was clear at Al-Kendi Intersection and Tunes Street.
- One fourth of crashes occurred because drivers “failed to maintain distance” and one-fifth occurred because of “not taking safety measures for pedestrians while crossing”. These causes were relatively high on Faisal Street and Rafeedia Street. These were prevalent causes at some of the selected locations.

### **Recommendations**

The results of road crash analysis raise several issues that deserve to be followed up and further investigation by decision makers and researchers. This kind of studies has a clear message to decision-makers and researchers since it provides general guidelines for the development of various aspects of a national traffic safety program. The followings are study recommendations or issues to be further investigated and studied.

- The competent authorities in Palestine that collect traffic crash data should use the universal scientific methodology in recording traffic crash data using a practical model in recording crash information. In addition, they should develop appropriate mechanisms for storing the database to serve traffic safety studies as well as other needs. Therefore, this will facilitate the process of accurately assessing the conditions of the traffic safety conditions and identifying hazardous locations.
- Studies should be conducted to explore the reasons for the increase in the number of crashes and fatalities, and identify ways to reduce them.

- In general, crash frequencies show that it is necessary to conduct safety studies for Sufian Street and Omar Bin Al-Khattab Street, and for Al-Ghawi and the Western Graveyard Intersections.
- Crashes under rainy and wet road surface conditions should be further studied with particular focus on Hamdi Kan'an and Prince Mohammad Streets with suggested solutions for water drainage problem.
- Night time / lighting conditions should be investigated on Rafeedia Street and Al-Fatimia Intersection.
- Non-compliance to traffic signals on Faisal Street, intersections of Al-Salam Mosque, Al-Ghawi, Al-Fatimia, and Western Graveyard should be of interest to researchers and decision makers to identify reasons and proper actions to remedy this problem.
- A detailed safety study is warranted on Faisal Street in general and in front of the National Hospital in particular since it includes half of crash fatalities in the city.
- It is crucial to further investigate pedestrian crashes with particular focus on Rafeedia Street and on Western Graveyard Intersection.
- Although not investigated in this research, it is recommended to study the role of public transport sector in traffic safety in Nablus city as there is a perception that this forms a significant percentage of crashes in the city.
- Comprehensive traffic safety awareness campaigns should be conducted with emphasis on drivers obeying traffic signs and laws, pedestrians related issues (priority of the road and compliance to safety measures).
- Future studies should use info-graphics in explaining and presenting particular crash patterns presented in this research so that results are more clear and better understood by the readers.

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