

Accidents Analysis of Kandahar-Spin Buldak Highway in Afghanistan

Shahzada Ulfat, Abdul Wahid Wahidi, Farhad Ahmadzai

Assistant Professor in Civil Engineering Department, Kandahar University, Afghanistan

Abstract— The study aims to identify and prioritize the accidental blackspots locations on Kandahar – Spin Buldak highway located in Afghanistan. The hazardous locations (blackspots) are identified by the APW (Accident Point Weightage), EPDO (Equivalent Property Damage Only), and RQC (Rate Quality Control) methods. In the first step; APW and EPDO methods identified Km 7th, Km 20th, Km 47th, Km 62nd and Km 90th as blackspot locations on Kandahar – Spin Buldak highway, however, integrating all three methods (RQC, APW and EPDO); the Km 7th and Km 20th are recognized as critical hazardous locations alongside this highway.

While practically and theoretically high number of crashes occur in locations where there is higher AADT, surprisingly, this paper found critical blackspots locations alongside Km 7th and Km 20th segments of the highway (having almost equal and less AADT in comparison with 47th, 62nd and 90th Km).

Keywords— Blackspot, EPDO method, APW method, Rate Quality Control method and Crashes.

I. INTRODUCTION

Afghanistan is one of the developing countries having high level of traffic accidents. Increase in the number of vehicles on the roads results high accident rates. Hence, comprehensive studies are required to take place in order to address problems and propose solutions for the accident rates that cause not only health loss but also social and economic loss in developing Afghanistan. The total number of accidents in Afghanistan were 4,397 in 2014, in which 6,448 were fatalities. The age adjusted death rate is 21 per 100,000 of population ranked 23rd in the world (WHO, 2014; CSO, 2015).

Rapid economical and industrial rise all over the country directly contributes to higher number of individual car ownerships, which leads increasing accidents frequency and severity as shown in “Fig. 1” (MTCA AFGHANSITAN, 2017).

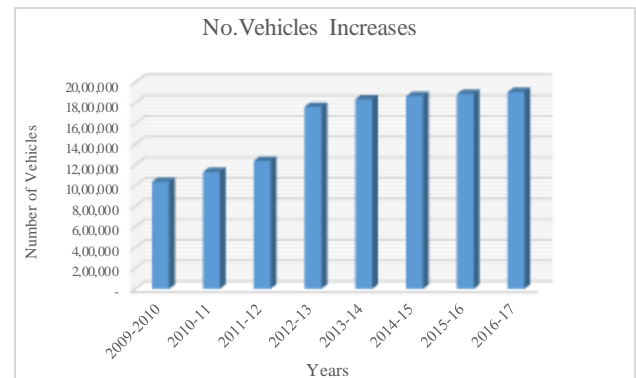


Fig. 1: Growth of vehicles (2010-2017)

“Fig. 1” Shows the number of vehicles increases after each year. The average world fatality rate per 10,000 vehicles is 19 and is 2 per 10,000 vehicles in developed countries (Aung S. N., 2014). Whereas, the fatality rate in Afghanistan is above 30 per 10,000 vehicles for the past five years (from 2010-2014) (WHO, 2015).

Kandahar is the second biggest province of Afghanistan and its Spin Buldak district is the second major entry between Afghanistan and Pakistan which named Wesh-Chaman border crossing. It is also a major transporting and receiving site between the two neighboring countries. Kandahar to Spin Buldak is one of highways of Kandahar province which connects Wesh-Chaman border to the city of Kandahar province. Many people always cross and go through this highway by land transport in terms of cars, vans, and buses.

Its design speed is 90 Kilo meters per hour and its reconstruction work was started in 2008 and ended on 2010. The pavement width is 25 ft. and with 6 ft. of shoulders. In this route, there are many accidents taking place recently because of many people use this highway for many purposes such as business, offices work, diplomacy and leisure time. There are 347 vehicles crashes with 311 fatalities and 784 injuries from November 2012 to December 2015 (KMRH, 2015). The reasons behind these accidents rates are inadequate capacity of roads, speeds and human errors.

II. STUDY AREA

Kandahar -Spin Buldak highway is located in the East of Kandahar city. It is one of the main highways of

Kandahar province which links Wish Chaman border to the city of Kandahar. Many people always cross and go through this highway by land transport in terms of cars, vans, and buses. In the other hand, it is the core highway between the southern of Afghanistan and the topography is generally plain and rolling surface but some parts are also mountainous region. 5 years accident data (2012-2016) has been used for this highway and the considered total length of the study area is about 105 Kilometers along this highway as shown below.

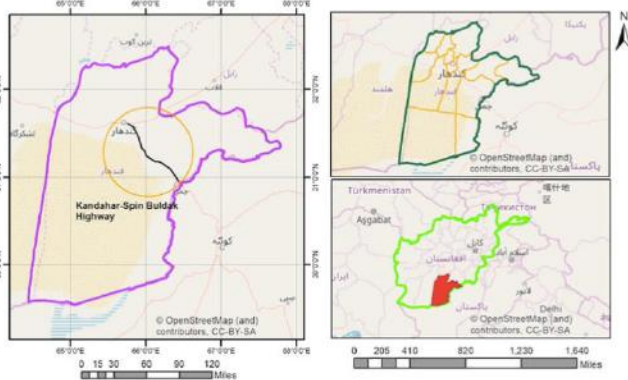


Fig. 2.1 Vicinity map of Kandahar-Spin Buldak Highway

III. METHODOLOGY

The study is conducted in two parts:

- ✓ To identification and analysis of accidental blackspots through EPDO, APW and Rate Quality control methods.
- ✓ To Prioritize the blackspots through comparison of EPDO, APW and Rate Quality Control methods

3.1 Framework

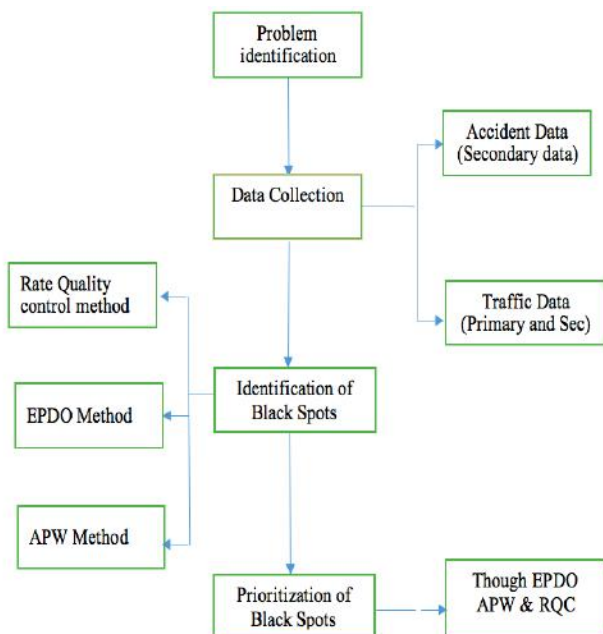


Fig.3.1: Flow chart of the research

3.2 Data Collection

Related accident data collected from highway department, traffic police department, Kandahar Mirwais Regional Hospital, WHO, UN-Habitat and international organizations. Fig.3.1 shows the number of accidents and fatalities over the past four years.

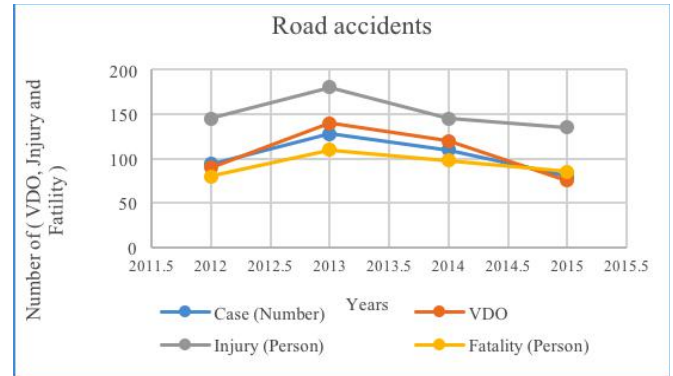


Fig. 3.1 Accidents Cassese with fatality, Injury and PDO
Source: Kandahar police traffic department data 2017

3.3 Methodology for blackspots Analysis

In this study, three methods have been used to identify and prioritize the blackspot locations namely accident point weightage method (APW), equivalent property damage only method (EPDO) and Rate Quality control methods.

3.3.1 Accident Point Weightage (APW) Method

Identification and prioritization of blackspots location were carried out by using ranking accident point weightage method. In this method, the accidents were divided into three groups. For property damage only it was multiplied with 0.2 while multiply with 3.0 and 6.0 injury and fatality respectively.

$$APW = KF + KI + KP \tag{1}$$

Where, W = Coefficient of Weight

F = Fatality Frequency

I = Injury Frequency

P = PDO Frequency

K values for Fatality is 6, Injury is 3 and PDO is 0.2

3.3.2 Equivalent Property Damage Only (EPDO) Method

Another method which has been used to identify the blackspots location was equivalent property damage only method (EPDO). In this method considered weights of an accident is based on its severity of accident. The weight of fatality is higher than injury and vehicle damage only. The severity index is calculated based on using the equation of Campbell and Knapp (Campbell, 2005). The following mentioned procedure have been used for EPDO method. The EPDO Severity is mentioned by equation:

$$SI = [WK + WI + WP] / T \tag{2}$$

Where,

SI = severity index

W = weight coefficients

K = frequency of fatality

I = frequency of injury

P = frequency of property damage only

T = total accidents

The EPDO index is mentioned by equation:

$$\text{EPDO Index} = (\text{WK} + \text{WI} + \text{WP}) \quad (3)$$

* total accidents

The EPDO rate is mentioned by:

$$\text{EPDO rate} = [\text{EPDO Index}] \quad (4)$$

/ [(Exposure per day) * Days]

Or EPDO rate = [EPDO Index] / [(Exposure per day) * total days during analysis period]	
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The exposure per day times days is called and the exposure rate that is the total days during the analysis period which is equal to 1,460 days (365*4).

3.3.3 Rate Quality Control (RQC) Method

The rate quality control method is used in the hazardous locations which compare the traffic crashes rates for roadway segments with similar characteristics to determine the critical and average crashes rate for all specified locations of road. The formula to find the critical crash rate at highway is follows:

A section *j* is considered to be a blackspot, from the accident rate point of view, if:

$$R_j > R_c, \text{ Where the } R_c$$

$$= R_a + K \sqrt{\frac{R_a}{M_j} + \frac{1}{2M_j}} \quad (5)$$

$$R_a = \sum_1^n (A_j / M_j) \quad (6)$$

R_c: Critical crashes rate for a particular location (crashes per million vehicles or crash per million vehicle-km)

R_a: Average crashes rate for all road locations (crashes per million vehicles or crash per million vehicle-km).

K: Probability factor determined to be the level of statistical significance desired for *R_c*,

α = 10% considered, then the *K* value is 1.28 from normal distribution

M_j: Number of vehicles traversing particular road section (millions of vehicle-km) or number of vehicles entering particular section.

R_j : is the accident rate on section *j* during that time period (not for all section).

A_j: is the number of accidents on section *j* during a certain time period.

IV. RESULT AND DISCUSSION

For the result, three methods have been used to identify the blackspots locations namely accident point weightage (APW), equivalent property damage only (EPDO) and Rate Quality control as shown below 4.1 tables.

4.1. Accidents Cases

Average occurred accidents cases during 4 years have been shown in below table 4.1.

Table 4.1: Illustrates the average occurred accidents cases during 4 years (2012-2015)

No	Name of Location	location (Km)	Cases (Average/year)	VDO (Average/year)	Injury (Average/year)	Fatality (Average/year)
1	Shorandam	7	12	13	37	10
2	Torkotal	39	8	10	16	5
3	Airport Entrance	20	14	16	52	6
4	Intjergai	56	6	8	9	7
5	Mandah	47	5	6	5	13
6	Bazo Chaki	72	6	8	8	6
7	Milpole	62	5	6	21	3
8	lagak Manda	90	7	8	17	8
9	Sharano	80	3	4	6	3
10	Tarnak	28	6	9	10	2
	Total (Average for four year)		72	88	181	63

4.2. Result by Accident Point Weightage Method (APW)

Identification and prioritization of blackspot locations were carried out by using ranking Accident Point Weightage method. In the result, Km 7th, Km 20th, Km 47th, Km 62nd and Km 90th were the hazardous locations.

The Km 20th was the first, Km 7th is second, Km 90th is third, Km 47th is fourth and Km 62nd is the fifth hazardous locations on Kandahar to Spin Buldak highway. The remain five also categorized according to APW ranks as shown in table 4.2.

Table.4.2: Identifying and Ranking of blackspots locations by APW Method.

Location (Km)	Accident Types						APW	Rank
	Fatality	Fatality x Factor (6)	Injury	Injury Factor (3)	PDO	PDO x Factor (0.2)		
7	10	60	37	111	13	2.6	173.6	2
39	5	30	16	48	10	2	80	6
20	6	36	52	156	16	3.2	195.2	1
56	7	42	9	27	8	1.6	70.6	7
47	13	78	5	15	6	1.2	94.2	4
72	6	36	8	24	8	1.6	61.6	8
62	3	18	21	63	6	1.2	82.2	5
90	8	48	17	51	8	1.6	100.6	3
80	3	18	6	18	4	0.8	36.8	10
28	2	12	10	30	9	1.8	43.8	9

4.3 Results by Equivalent Property Damage Only Method (EPDO)

In Equivalent Property Damage Only method result that, the Km 47th, Km 62nd, Km 20th, Km 7th and Km 90th had

the high values of EPDO rate compared to the rest five locations. Therefore these five locations Km 47th, Km 62nd, Km 7th, Km 90th and Km 20th were in the hazardous locations as shown in table 4.3.

Table.4.3: Identifying and Ranking blackspots locations by Equivalent Property Damage Only (EPDO) Method.

Location (Km)	Ave Acc/KM	Fatality	Fatality x Factor (6)	Injury	Injury Factor (3)	PDO	PDO x Factor (0.2)	SI	Acc(to t)	EPDO Index	Days	EPDO Rate	Rank
7	12	10	60	37	111	13	2.6	14.47	347	5019.93	1460	3.44	3
39	8	5	30	16	48	10	2	10.00	347	3470.00	1460	2.38	9
20	14	6	36	52	156	16	3.2	13.94	347	4838.17	1460	3.31	5
56	6	7	42	9	27	8	1.6	11.77	347	4083.03	1460	2.80	7
47	5	13	78	5	15	6	1.2	18.84	347	6537.48	1460	4.48	1
72	6	6	36	8	24	8	1.6	10.27	347	3562.53	1460	2.44	8
62	5	3	18	21	63	6	1.2	16.44	347	5704.68	1460	3.91	2
90	7	8	48	17	51	8	1.6	14.37	347	4986.89	1460	3.42	4
80	3	3	18	6	18	4	0.8	12.27	347	4256.53	1460	2.92	6
28	6	2	12	10	30	9	1.8	7.30	347	2533.10	1460	1.74	10

4.3 Rate Quality Control Method

Table 4.5 illustrate the result by rate quality control method. As the accident rate (R_j) on Km 7th and Km 20th are greater than Critical accident rate (R_c) therefore, Km 7th and Km 20th are the blackspot locations and the rest of three are not included in blackspots. In this method, the accident critical value and accident rate for a section is

depending on entering of vehicle to the section during specific time period and accidents number occurred on that section at the same period of time.

Table.4.5: Identifying and Ranking blackspots locations by Rate Quality Control method.

Location (Km)	Ave Acc/Km	Mj (Veh/y in Million)	Aj (Ave Acc/Year)	Rj (Acc rate in Million-Km-year)	Ra (Ave Acc rate) = $\sum(A_j / M_j)$	K Value ($\alpha = 10\%$)	RC (Critical value) = $Ra + K \left(\frac{Ra}{M_j} \right)^{1/2} + 1/(2M_j)$	Comparison Rj and RC	Result
7	12	3.6792	12	3.262	2.002	1.280	3.082	Rj > RC	Blackspot
20	15	4.9056	15	3.058	2.002	1.280	2.922	Rj > RC	Blackspot
47	5	5.5188	5	0.906	2.002	1.280	2.864	Rj < RC	Not
62	5	3.6792	5	1.359	2.002	1.280	3.082	Rj < RC	Not
90	7	4.9056	7	1.427	2.002	1.280	2.922	Rj < RC	Not

Rc: Critical rate for a particular location (crashes per million vehicles or crash per million vehicle-km)

Ra: average crashes rate for all road location of like characteristics (crashes per million vehicles or crash per million vehicle-km).

K: Probability factor determined to be the level of statistical significance desired for Rc.

Mj: number of vehicles traversing particular road section (millions of vehicle-km) or number of vehicles entering particular intersection (millions of vehicles) during the analysis period.

Aj: is the number of accidents on section j during a certain time period.

Rj: is the accident rate on section j during that time period (not for all section).

4.4 Result by comparison of EPDO, APW and Rate Quality Control methods

By EPDO and APW methods five common from ten locations were included in blackspots but in Rate Quality control method only Km 7th and Km 20th were included. In EPDO and APW method the main considered factors were fatality, Injury and property damage but in Rate quality method the main factors which considered were number of accidents on specific section, period of time and entering of vehicle number to a specific section and the same specific time of period.

Table.4.6: Result by comparison of APW, EPDO and RQC Methods

Location (Km)	APW Rank	EPDO Rank	Rate quality Control Rank
7	2	3	Blackspot
90	3	4	Not
47	4	1	Not
62	5	2	Not
20	1	5	Blackspot

V. CONCLUSION

This study identifies the high crashes locations on the Kandahar – Spin Buldak highway in Afghanistan. High crash locations can be defined as any highway location which has a higher frequency of crashes compared to other roadway locations. The identification of road sections characterized by high risk accidents is the first step for any successful road safety management.

In this study, the hazardous locations (blackspots) are identified by the APW (Accident Point Weightage), EPDO (Equivalent Property Damage Only), and RQC (Rate Quality Control) methods. In the first step; APW and EPDO methods identified Km 7th, Km 20th, Km 47th, Km 62nd and Km 90th as blackspot locations on Kandahar –

Spin Buldak highway, however, integrating all three methods (RQC, APW and EPDO); the Km 7th and Km 20th are recognized as critical hazardous locations alongside this highway.

While practically and theoretically high number of crashes occur in locations where there is higher AADTs, surprisingly, this paper found critical blackspots locations alongside Km 7th and Km 20th segments of the highway (having almost equal and less AADT in comparison with 47th, 62nd and 90th Km).

The total number occurred crashes along highway were 347 cases with 412 vehicles damages only, 784 injuries and 311 fatalities. The feature of accident cases was increasing except year 2015 due to applied government

law enforcement on vehicle speeds and controlled the driver's license.

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