

## **Identification of “Black Spots” without Using Accident Information**

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### **Abstract**

In the present research, identification of so-called black spots with no use of accident information is investigated along “Iraanshahr-Sarbaaz-Chabahr” road in Baluchistan, Iran. First, by an overview on the road, all factors that could potentially contribute into accidents along the road were determined. Next, the road was divided into 8 sections based on uniformity and homogeneity of each section in terms of geometry and regional conditions. At each section, potential black spots were identified and questionnaires were prepared to collect opinions from 30 experts who were well-familiar with the road. The collected data was analyzed using SPSS Software, leading to the identification of black spots. Finally, the identified black spots were compared against those obtained by traffic police based on accident information.

**Keywords:** Accident, Black spot

### **1. Introduction**

Based on the latest estimation by World Health Organization (WHO), about 1.25 million individuals lost their life due to injuries incurred via road accidents, with another 20-50 millions of individuals being physically disabled as a result of road accidents and incidents. Road accidents are known as the 9<sup>th</sup> major cause of death among 15-29 years old individuals all around the world, with more than 60% of the road casualties happening to 15-44 years old individuals. Whilst the count of registered vehicles during 2000-2013 period has increased by 90%, road casualties have been less significant. Interventions to improve road conditions have largely contributed into road safety and reduced road casualties throughout the world. During 2010-2013, 79 countries have succeeded to reduce their count of road casualties, indicating the feasibility to improve road conditions to save many people’s lives.

According to WHO, in 2012, Iran had the road casualties as the third cause of death following ischemic heart disease and stroke; and since road casualties and associated physical

disabilities tend to impose a large deal of economic cost on governments, road modification and improvement can be considered as highly justified. The locations along a road wherein highest number of accidents occur are referred to as *black spots*. Identification and modification of such spots can significantly contribute into reducing number of the accidents.

A large deal of research has been focused on the identification of black spots. For instance, Shabiraliyani et al. (2015) investigated a black spot in Ghazi-Khan Valley in Pakistan. In their research, they aimed to study effects of associated risks with road traffic on society, and the factors contributing to the occurrence of the accidents at the Ghazi-Khan Valley. In their study, they found out that human mistakes constitute the largest cause of the road accidents and in more than 80% of the cases in Pakistan, drivers' mistakes ended up with serious injuries. Cláudia et al. (2015) analyzed and described black spots for vulnerable users of the road including cyclists and pedestrians in Brazil and Italy. The paper determines spots and areas described by the severity of road accidents measured by casualties and injuries in a developing country (Brazil) as well as a developed one (Italy). Chen (2013) used GIS to determine and characterize black spots via spatial analysis. In that paper, a discussion is presented on how to implement geographical coordination technology to record accidents with geographical information attached, and the relation between black spots and traffic features is used analyzing factors affecting the accidents. Agarwal et al. (2013) proposed a method for ranking black spots using AHP. Their method presents a four-step ranking approach for black spots wherein no accident information is used. Nguyen et al. (2016) addressed an approach towards identification of black spots based on saving road costs. and Behzadi (2016) prioritized four conventional methods, namely those based on frequency, rate, severity, and rate-severity, and proposed a hybrid method using AHP. Borsos et al. (2016) compared ranking of black spots in Italy and Hungary and introduced the methods and operations undertaken in either of the countries to identify and rank the black spots. Isen et al. (2013) used GIS to identify and analyze black spots. Resham E.K and Sheikh Omar Sharif (2012) proposed a method in which the accident analysis includes prioritization of some major Black spots by the use of CURVEGIS 10 software package. The study area includes some major accident spots in south Bangalore, Karnataka in India. Sadeghi et al. (2013) presented a new method for affecting environmental traffic and geometric characteristics to identify black spots. Klein-hebling et al. (2014) conducted all emphasizes on reducing nuclear disasters risk and summarize the concluding results of the work in the SARP group. Gononi and Saleh (2016) discussed near-miss management system and accident precursors by bringing two strands together including the examining of near miss management system and the development of general domain independent system safety principle. They collect and prioritize anomaly and precursor data and transform it to safety improvements. La Tore et al. (2016) studied a method of accident prediction modelling in Europe that could be applied to different road network using crash modification factors.

In order to have a safe road, it seems necessary to identify and modify black spots. However, most of the methods proposed for identification of the spots rely on accident information and since the information is time-consuming and casualty-intensive to acquire, it can be very advantageous to present a method which can identify the black spots within a short time, so as to reduce the casualties and establish safe roads.

## 2. Research Methodology

The present research identifies and prioritizes black spots along the “Iraanshahr-Sarbaaz-Chabahr” road (Fig. 1), this two lane highway is an essential mountain road for the region connecting strategic port of Chabahar (Baluchistan, Iran) which is the only seaport in Iran with direct access to the Indian ocean .This highway is undertaken by investigating and analysing of the road and environmental, traffic, and geometrical conditions. For this purpose, first, entire length of the road was checked for factors which were expected to contribute into accidents along the road; listed as A to I, the factors were as follows:

- A. Inappropriate horizontal curves
- B. Inappropriate vertical curves
- C. Lack of traffic signs
- D. Lack of adequate lighting at night
- E. Inappropriate sight distance
- F. Lack of road shoulder
- G. Lack of guard rail and passage of animals across the road
- H. Traffic of smugglers’ vehicles
- I. Lack of interchanges at residential areas



**Fig. 1:** The Iraanshahr-Sarbaaz-Chabahr road

Following with the research, the “Iraanshahr-Sarbaaz-Chabahr” road was divided into 8 uniform and homogenous sections in terms of physical and road performance properties. The sections were as follows:

- Section 1 - Iraanshahr-Polchamani
- Section 2 - Polchamani-Kalaat
- Section 3 - Kalaat-Sarbaaz
- Section 4 - Sarbaaz-Pashaamag Mortaan
- Section 5 - Pashaamag Mortaan-Jakigor

- Section 6 - Jakigor-Dashtyari
- Section 7 - Dashtyari-Konaarak
- Section 8 - Konaarak-Chaabahaar

At each section, potential black spots along the section were identified based on the geometry of the road within that section, environmental factors and also the 9 factors mentioned above. Potential black spots along the Sections 1-8 are reported in Tables 1 to 8, respectively.

**Table 1:** Section 1 - Iraanshahr-Polchamani

<b>potential black spots</b>	<b>Cause of having potential</b>
Shahrderaz	Lack of interchanges at residential areas, Traffic of smugglers' vehicles

**Table 2:** Section 2 - Polchamani-Kalaat

<b>potential black spots</b>	<b>Cause of having potential</b>
Kalaat	Lack of interchanges at residential areas, Traffic of smugglers' vehicles

**Table 3:** Section 3 - Kalaat-Sarbaaz

<b>potential black spots</b>	<b>Cause of having potential</b>
Sarbaaz	Lack of interchanges at residential areas, Lack of adequate lighting at night, Lack of road shoulder

**Table 4:** Section 4 - Sarbaaz-Pashaamag Mortaan

<b>potential black spots</b>	<b>Cause of having potential</b>
Dapkor	Lack of interchanges at residential areas, Inappropriate Horizontal Curves
Bepaataan	Inappropriate Horizontal Curves, Traffic of smugglers' vehicles

As can be observed from Figure 2, the inappropriate horizontal curve together with the traffic of smugglers' vehicles have made Bepaataan a potential black spot.



**Fig. 2:** Section4 - Bepataan

**Table 5.** Section 5 - Pashaamag Mortaan-Jakigor

<b>potential black spots</b>	<b>Cause of having potential</b>
Garikaan	Lack of interchanges at residential areas, Inappropriate Horizontal Curves
Jangal	Lack of interchanges at residential areas, Inappropriate Horizontal Curves
Firouzabaad	Lack of interchanges at residential areas, Inappropriate Horizontal Curves, Inappropriate vertical curves
Derakhshaan	Lack of interchanges at residential areas, Inappropriate Horizontal Curves
Jakigor	Inappropriate Horizontal Curves

According to Figure 3, inappropriate horizontal and vertical curves along with lack of interchanges at residential area are among the causes contributing to car accidents across the locality.



**Fig. 3:** Section 5 - Firouzabad

**Table 6.** Section 6 - Jakigor-Dashtyari

<b>potential black spots</b>	<b>Cause of having potential</b>
Dashtyari	Lack of interchanges at residential areas, Lack of traffic signs

**Table 7.** Section 7 - Dashtyari-Konaarak

<b>potential black spots</b>	<b>Cause of having potential</b>
Oraki	Lack of interchanges at residential areas, Lack of traffic signs
Nobandian	Lack of interchanges at residential areas, Lack of traffic signs
Negor	Lack of interchanges at residential areas

Base on Figure 4, lack of traffic signs and the grade bi-way intersection at Nobandian are among the causes contributing to car accidents across the locality.



**Fig. 4:** Section 7 - Nobandian

**Table 8:** Section 8 - Konaarak-Chaabahaar

<b>potential black spots</b>	<b>Cause of having potential</b>
Konaarak	Lack of interchanges at residential areas
Tis Kopan	Lack of interchanges at residential areas

According to Figure 5, Konaarak bi-way crossing serves as a local black spot due to lack of traffic signs and intersection.



**Fig. 5:** Section 8 - Konaarak

For each section, two questionnaires were prepared and 30 experts who were familiar with the region were asked to score the effect of each factor contributing into accidents on 1-10 level scale. Questionnaire 1 was used to score each of the contributing factors into accidents, while Questionnaire 2 scored potential black spots based on each of the contributing factors into accidents.

### 3. Results and Analyses

The data obtained from questionnaires 1 and 2 were fed into and analyzed by SPSS Software. Accordingly, the results of questionnaire 1 were organized into Table 9 to find the most significant causes of accidents along each section, with the results of questionnaire 2 been organized into Table 9 to find the most accident-prone sections based on each cause of accident along each section of the entire route. All results exhibited a maximum level of significance of 0.05.

**Table 9:** Section 1 – Iranshahr-Polchamani

<b>The main factors of Accident</b>	<b>Mean</b>	<b>standard deviation</b>
Inappropriate horizontal curves	2.75	1.76
Inappropriate vertical curves	2	1.34
Lack of traffic signs	3.08	2.06
Lack of adequate lighting at night	4.75	2.49
Inappropriate sight distance	3.08	2.46
Lack of road shoulder	3.08	2.77
Lack of guard rail and passage of animals across the road	3.41	1.72
Traffic of smugglers' vehicles	6.91	2.1
Lack of interchanges at residential areas	5.08	3.5

According to Table 10, with an average of 6.91%, the most significant cause of accident along Iraanshahr-Polchamani was found to be traffic of smugglers' vehicles. Moreover, based on the obtained results, inappropriate horizontal curves represent the most significant cause of accidents along the Sections 2 and 3 (7.58% and 7.16%, respectively). Along Section 4, as the top cause of road accidents, traffic of smugglers' vehicles caused, on average, 7.83% of all accidents occurred, while inappropriate horizontal curves were found to be the most significant cause of accidents along the Section 5 causing an average of 7.08% of all accidents along this section. Section 6 was once more dominated by traffic of smugglers' vehicles which caused an average of 5.75% of all accidents, with Sections 7 and 8 suffering from lack of interchanges at residential areas as the main cause of accidents, being responsible for averages of 5.83% and 5.33% of accidents along Sections 7 and 8, respectively.

**Table 10:**How accident-prone is each section due to inappropriate horizontal curves

Section	Mean	Standard Deviation
Iraanshahr-Polchamani	2.75	1.76
Polchamani-Kalaat	7.08	1.88
Kalaat-Sarbaaz	7.08	3.01
Sarbaaz-Pashaamag Mortaan	6.5	2.39
Pashaamag Mortaan-Jakigor	7.08	1.72
Jakigor-Dashtyari	4.5	2.11
Dashtyari-Konaarak	3.25	1.71
Konaarak-Chaabahaar	2.91	1.56

According to Table 10, with an average of 7.08%, Sections 2, 3, and 5 were found to be the most accident-prone routes based on the factor of inappropriate horizontal curves.

On the basis of the obtained results, inappropriate horizontal curves along Section 2 (average: 5.41%), lack of traffic signs along Section 3 (average: 5), lack of adequate lighting at night along Section 2 (average: 5.41%), inappropriate sight distance along Section 2 (average: 5.7%), lack of road shoulder along Sections 3 and 6 (average: 4.66% for both sections), lack of guardrail along Section 5 (average: 4.66%), traffic of smugglers' vehicles along Sections 1, 4, and 6 (average: 7.83%), and lack of interchanges along Sections 7 and 8 (average: 5.83%) were found to be the most effective causes of accidents.

#### 4. Conclusion

Comparing the results of the analyses on the two questionnaires, three causes were found to have the largest contributions into road accidents at black spots along "Iraanshahr-Sarbaaz-Chabahaar" route: 1) lack of interchanges along "Dashtyari-Konaarak" and "Konaarak-Chaabahaar" routes, 2) inappropriate and non-standard horizontal curves along "Polchamani-Kalaat", "Kalaat-Sarbaaz", "Sarbaaz-Pashaamag Mortaan", "Pashaamag Mortaan-Jakigor", and "Jakigor-Dashtyari" routs, and 3) traffic of smugglers' vehicles being driven carelessly at too high speeds along "Iraanshahr-Polchamani", "Sarbaaz-Pashaamag Mortaan", and "Jakigor-Dashtyari" routes. Comparing and evaluating the three main causes of accidents and potential black spots along this route from Tables 1 to 8, the final black spots were defined as in Table 11.



**Table 11:** Identification of black spots without using accident information

	<b>Black spots</b>
1	Shahrderaz
2	Dapkor
3	Bepaataan
4	Garikaan
5	Jangal
6	Firouzabaad
7	Derakhshaan
8	Jakogor
9	Oraki
10	Nobandian
11	Negor
12	Konaarak
13	Tis Kopan

According to the stats released by Iranian Traffic Police in 2015, black spots along this route include Kalaat, Depkor, Bepatan, Grikan, Forest, Firoozabad, Derakhshan Gas Station, Jakigor, Oraki, Nobandian, and Nagur. Accordingly, the black spots reported in Table 11 coincided with the police report at 10 locations.

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