Evaluation of the Locations of Emergency Medical Service Based Black Spots on the Highway: a Case Study Darbandikhan Town

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Abstract— Today, road safety plays as key and integral role in a sustainable transportation development strategy in the most countries. One of the major steps in improving road safety is the specification of the locations with an unusual high number of accidents which is defined black spots. This paper attempts to reduce accident frequency or severity in the road network of Darbandikhan town through two things. The first is identifying the black spots on road network and arrange it according to their severity to specify the priority in treatment. The second is evaluating the effectiveness (response time) of the current locations of emergency medical service (EMS) based on black spots by using ArcGIS10 software. The results define 16 black spots in road network in the Darbandikhan town as a case study, and show improper locations for the emergency medical services. The outcomes of this study can find a way for prioritizing the black spots which need to remedial treatment to improve road safety. Also, it can be used to assess the current locations of EMS and consequently, reducing the numbers of deaths and unnecessary suffering of injured people.

Index Terms— Arc GIS10, black spots, EMS (Emergency Medical Service), EPDO, response time.

1. INTRODUCTION

ROAD accidents are a major economic and social problem in many countries around the world. According to WHO (World Health Organization) the number of fatalities from road accidents per year of about 1.24 million and 20 to 50 million more people suffer from non-fatal injuries, with many incurring a disability as a result of their injury. In addition to the loss of lives, road accidents cause huge economic losses that reach to 1-3% of the gross national product for most countries [1]. So, today road safety is a big issue on our roads and accident analysis plays an important part in the strategy to reduce road accidents [2]. A precondition for the management of road traffic safety is the systematic collection of data on traffic accidents that will enable the identification and determination of the place where there are high concentrations of road accidents [3]. The location in a road where the traffic accidents often happen is termed a black spot. Identification of black spots is a basic element of highway safety improvement system. It gives rise to assign the priority on sites considered road network investigation that is the first step in road safety improvement.[1]

Despite, the increasing number of road accidents nowadays, availability of emergency medical services in the proper time can play an important role in reducing the severity of the road accidents. Hence, ambulance response time is considered a key benchmark in measuring the quality of the EMS. Response time is defined as the time it takes for an emergency vehicle to arrive at the scene upon receiving injuries [4]. Many studies indicate that improved medical response time is an important factor to decrease the severity of long –term injuries [5]. For example, Sanchez-Mangas et al. [6] suggest that mortality rate of road traffic accidents can be reduced to one third with a 10-minute reduction of response time.

In general, ambulance response time that is longer than 15 minutes is unacceptable [7]. Therefore, strategic location of ambulances is the main factor that can reduce the response time, and subsequently lessening the losses in life. In this regard, in this paper after the identification of the location of black spots and prioritized them according to severity by using EPDO value, the evaluation of the response time for the current locations of emergency medical service based on black spots was conducted by using Arc GIS10.

2. STUDY AREA

Darbandikhan is a town belongs to Sulaimani province. Darbandikhan consists of mixed types of land use pattern mainly commercial, residential and touristy. In addition to that, the town related road network plays a vital role in the transportation system between the Sulaimani city and Kalar city, and between Iraq and Iran, so Darbandikhan involves a heavy and mixed type of traffic and this in turn results in many accidents. In spite of these, the region contains only two locations for emergency medical services.

The heavy traffic population, traffic congestion, the topographical nature and the two lane routes in this region causes delay in carrying of accidents' victim to hospitals. Hence, Darbandikhan is selected for the present study as study area.

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Fig (1) the study region

3. METHOLOGY AND MATERIAL USED

3.1 Determination of Black Spots

In order to determine the black spots on the highway, accidental reports from 1 January 2011 to 31 December 2013 for the highway of the study region were collected from the traffic police office in Darbandikhan city. These reports contain description of the location of the accidents, crash types, human fatal, human injuries, and material damages. The total numbers of the reports were 341. Then, a combination of frequency method and severity method were used to determine the black spots on highway. The purpose of using the two methods was to increase the degree of accuracy of identifying black spots on highway.

3.1.1 Crash Frequency Method

The crash frequency is defined as the number of crashes for a given location [8]. To determine the black spots on the highway, the map of the highway was divided into small segments. The length of every segment was 300m. Then the accidents were distributed on these segments. Every segment has six accidents or more was considered as a black spot. Then these locations were visited and determined by using GPS.

3.1.2 Crash Severity

Crash severity is often defined using the Estimated Property Damage Only (EPDO) system, in which the severity of a crash is represented as one of three values. When a crash results in property damage only, it receives a value of one. A crash in which someone is injured will receive a value of five. The most severe crash, one which results in a fatality, is represented with a ten [9].

EPDO= property damage only crashes+5 X injury crashes +10 X fatal crashes ……..……(1)

The EPDO value was calculated for the black spots (that determined by frequency method) to priority them according to severity.

3.2 Analyzing the Data with the Arc GIS10

To evaluate the efficiency of the locations of emergency medical service to the black spots on the highway Arc GIS10 was used. In the beginning GPS survey is conducted to locate EMS and black spots. Then, three layers were used in the analysis. They are roads, black spots and EMS. The following flow chart shows the process of analysis by using Arc GIS10.

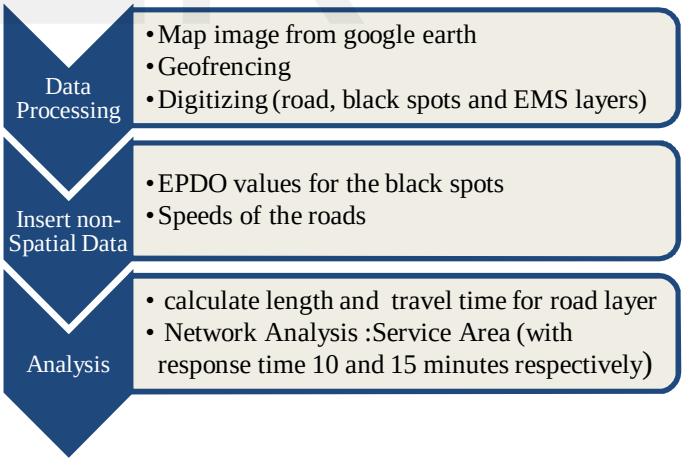

Fig (2) Procedure of analyzing by using Arc GIS10

4. RESULTS AND DISCUSSION

4.1 Analysis Results from Crash Frequency Method

By using crash frequency method, 16 black spots (which have 6 accidents or more) were determined on the highway. The table below shows the black spots on the highway and the number of accidents in every location. The black spots were arranged in sequence from the beginning to the end of the highway.

Table (1) the black spots according to crash frequency method

Location	No. of accidents
1	19
2	10
3	9
4	8
5	14
6	6
7	7
8	9
9	12
10	6
11	9
12	6
13	10
14	11
15	13
16	6

From table (1) it can observe that the locations 1, 5 and 15 respectively are the most dangerous locations according to crash frequency method.

4.2 Analysis Results from Crash Severity Method

Accident severity method (EPDO) was used to rank the locations in order of priority. The table below shows the black spots and the value of EPDO for every location.

Table (2) the black spots according to crash severity method

Location	Fatal	Injury	Property damage	EPDO
1	3	11	5	90
2	1	6	3	43
3	----	5	4	29
4	2	5	1	46
5	2	7	5	60
6	2	2	2	32
7	----	3	4	19
8	----	4	5	25
9	1	7	4	49
10	----	3	3	18
11	----	8	1	41
12	----	3	3	18
13	2	6	2	52
14	3	6	2	62
15	4	8	1	81
16	----	2	4	14

From table (2) it can note that the locations 1, 15 and 5 respectively are the most dangerous location according to the crash severity method.

From table (1) and (2) it can note that the difference in arrangement of dangerous the black spots between the two methods. This may due to that the frequency method tends to rank locations according to the number accidents, even if those locations have no number of deaths or injured. In other words, it ignores the severity of accidents. On other hand, crash severity method attaches greater weight to crashes resulting in a fatality or an injury and lesser weight to crashes resulting in property damage. Hence, crash severity method provides a reliable start to the prioritization of safety improvements.

4.3 Result of Analyzing the Data with the Arc GIS10

Fig (3) shows the black spots in the road network of Darbandikhan town. These locations are arranged based on EPDO value. According to this figure, the locations 1 and 15 were the most hazardous locations according to the severity of accidents. Furthermore, fig (4) shows service area of EMS location along the route for two different response times, 10 and 15 minutes respectively. According to fig (4) EMS location did not cover two of the black spots by 10 or 15 minutes. One of them is the location 15 which is considered one of the most dangerous locations in the study region. It means that the crash fatalities in these points do not have opportunity for survival in serious crashes.

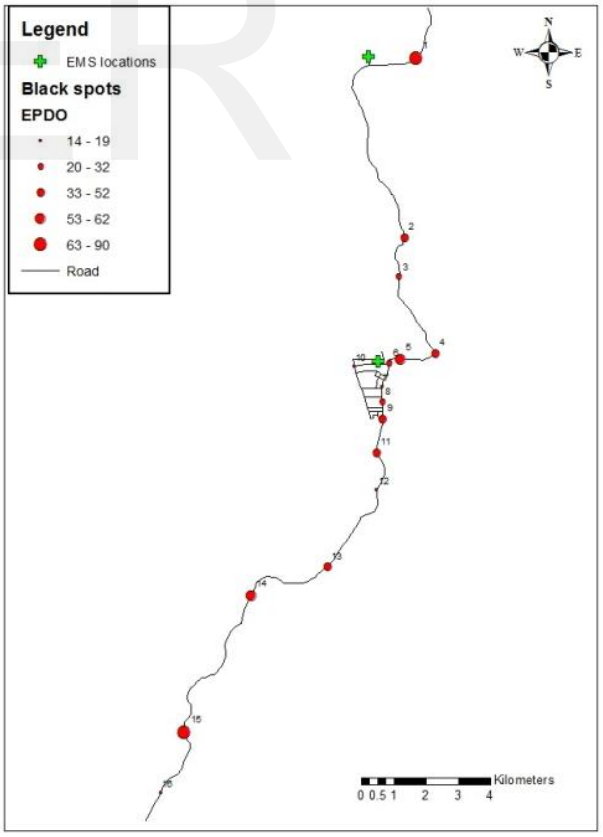

Fig (3) Accident black spots in the road network in Darbandikhan town

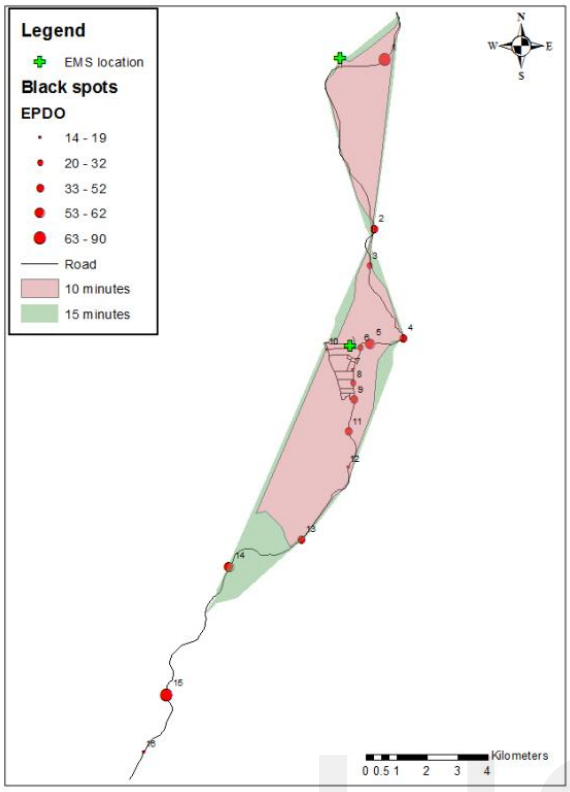

Fig (4) EMS service area with different in the road network in Darbandikhan town

5. CONCLUSIONC

Since accidents is spatially distributed in nature, use of geographical information system can offer the ability to store data, update data, compared data and spatially display of data. So, in this paper the black spots were determined spatially by using Arc GIS10 software and arranged according to their servility to determine the priority of dangerous locations which need to remedial treatment in order to improve road safety. Moreover, the evaluation of the effective (response time) for the current locations of EMS based black spots indicate that the locations of EMS are not appropriate positioned relating to black spots and this can cause pre- hospital death as a result increase the severity of accidents .

6. RECOMMENDATIONS

1. The defined black spots must be visited to understand the reasons behind why many traffic accidents occur at these locations.
2. Relocate the current locations of EMS to ensure that these new locations can be achieved the standard response time
3. Increase the number of lanes from two lanes to four lanes to increase the speed of EMS and then decrease the response time.

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