Sequential Data Analysis for Black Spot Identification

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Introduction

Road accident has long been one of the major problems causing economic and social losses in Thailand. Studies show that the total annual traffic accident cost reaches 3 percent of the country's GPD or about 120 billion baht. The major causes of road accidents are road user, vehicle condition, and road environment, where the proportions are shown in Figure 1.

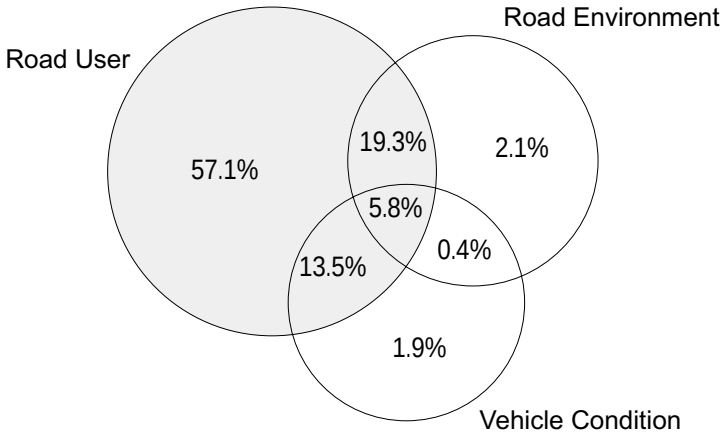

Figure 1 : Causes of Road Accidents in Thailand

Even though road accidents are unpredictable in most cases, road safety devices and geometry improvements of hazardous locations on highways can either minimize the chance of accident occurrence or reduce accident severity. As can be seen in Figure 1, road environment contributes to 27.60 percent in overall accidents. Therefore, an accurate tool to identify black spots and hazardous locations on highways based on historical accident data is an important step that would help locate problematic locations on highways for safety engineers to analyze causes, propose solutions, estimate budgets and set prioritizations.

Black Spot Criteria

Highway black spots are highway locations where the potential for accidents is unacceptably high. The most common assumption for a black spot location is that there should be any road environmental or geometric issues resulting in the repetition of accidents. Since the criteria to identify black spots vary from country to country, international preliminary comparison is provided in Table 1.

Table 1: The Comparison of Black Spot Criteria

Country	Section Length	Frequency
Australia	Fairly Short	At least 3 casualty crashes in 5 years
England	300 meters	12 crashes in 3 years
Germany	300 meters	8 crashes in 3 years
Norway	100 meters	4 crashes in 3 years
Portugal	200 meters	5 crashes in 3 years
Thailand (DOH)	Vary	At least 3 crashes in 1 years

Sequential Pacing Data Analysis Technique

The conventional method used to identify highway black spots relies on fixed lengths of road sections, where the total length is divided into 300, 500, and 1,000-meter road sections. Next, the number of accidents happened within each road section is calculated and compared to the black spot criteria. However, the method is inaccurate because the section length is fixed where accidents within each section may not be related to each other. Moreover, the method tends to overlook hazardous locations in which the section lengths should be long enough to cover all continuous accidents that seem to be related to each other.

The sequential pacing data analysis technique simulates a manual method where road inspectors travel along a highway and inspect all accident records. As illustrated in Figure 2, nearby accidents within 100-meter of distance will be grouped together as a black spot location, where any accident located farther than 100-meter away from the current location will be assigned another black spot location ID. The algorithm for computer programming of the process is shown in Figure 3.

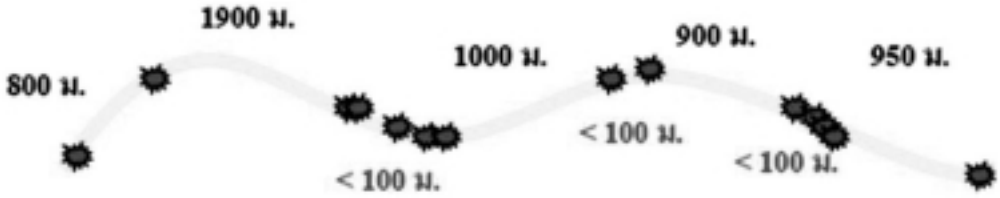

Figure 2 : The Algorithm for Black Spot Identification

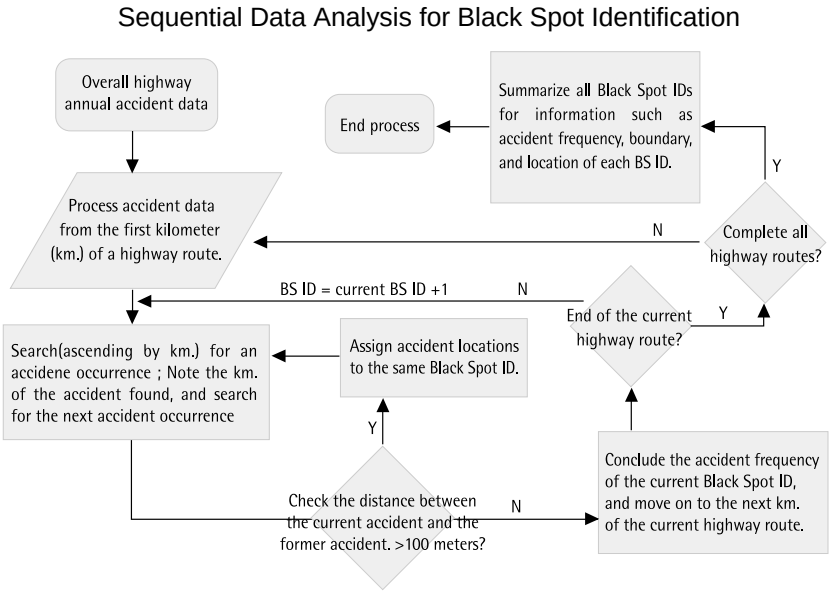

Figure 3 : The Algorithm for Black Spot Identification

From the figure, the total number of accidents within each black spot location will be summarized and compared to the black spot criteria. The process continues from the first to the last kilometer of each highway route and covers all highways under supervision of the department of highways. Based on the criteria mentioned earlier, the numbers of black spots identified in year 2006 and 2008 are shown in Table 2.

Table 2 : Analysis Results: Numbers of Black Spots (BS)

Accident Frequency (Times per year for any BS section)	Number of Identified Black Spots (2006 accident data)	Number of Identified Black Spots (2008 accident data)
2	1,608	1,519
3	748	698
4	459	448
5	316	325
6	241	252
More than 7	189	196

Since Thailand Department of Highway (DOH) has currently implemented on the criteria for black spot as shown in Table 1, the numbers of highway black spots identified from the process are 748 and 698 locations based on 2006 and 2008 accident data respectively.

In 2007, the list of 748 black spot locations based on 2006 accident data was distributed to 15 regional offices around the country for local engineers to investigate causes and propose solutions and budgets to the central office. The bureau of highway safety considered the data from all locations and prioritized black spot sites based on accident frequency, severity, total accident cost, and the proposed budget information. In 2009, which is the first year of highway black spot improvement program, DOH has received 400 million baht from the central government to improve 93 black spot sites, while the remaining sites are scheduled for the upcoming fiscal years.

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Black Spot Case Studies

The black spot list produced using the sequential pacing data analysis technique mentioned in the previous part, pictures of BS sites were taken by local engineers and sent to the central office in which six BS case studies are selected and discussed in Figure 4.

Highway 106 km. 29+410-29+470 (Lampoon - Lee): Sharp curve on mountainous area without chevron signs and insufficient roadway markings.

Highway 120 km. 45+400-45+800 (Phayao - Wang Nua): Highway junction without signalizations and insufficient roadway markings.

Highway 108 km. 34+100 - 34+200 (Sanpatong - Jomthong): Sharp curve with an opening entrance on slippery surface and no roadway lightings.

Highway 1 km. 638+435 - 638+500 (Lampang - Chiangrai): 1) Sharp horizontal curve mixed with vertical slope, 2) Speedy traffic with insufficient super elevation.

Highway 1035 km. 4+450 - 4+500 (Lampang - Jaehom): Opening U-Turn with a road junction on narrow right of way and poor roadway markings.

Highway 1001 km. 2+950 ? 2+961 (Chiangmai - Mae Joe): Opening U-Turn with a road junction, where local traffic conflicts with fast through traffic.

Figure 4 : Examples of Identified Black Spot Sites

Conclusions

The conventional method for highway black spot identification relies on fixed lengths of road sections. However, the major disadvantage of the method is that the hazardous section length must be fixed, which is contrary to the real-world situation where the section length varies depending on the characteristics of accident clusters. Moreover, the method tends to overlook a hazardous location because the fixed section length can split continuous accidents into two different BS sections. In fact, the section length should be flexibly long enough to cover all continuous accidents of a BS section, as long as those accidents are still within 100-meter of distance from each other.

The sequential pacing data analysis technique simulates a manual method based on a condition that nearby accidents within 100-meter of distance will be grouped together as a black spot location. Compared with the conventional method, the sequential pacing data analysis technique is more accurate in identifying black spots regardless of the BS section length. An accurate tool to identify black spots and hazardous locations on highways would help safety engineers to locate high-risk road sections. The list of black spot locations can be quickly distributed to 15 regional offices around the country for local engineers to investigate causes and propose solutions to the central office, where budgets and prioritizations can be strategically finalized.