APPLYING PUBLIC PARTICIPATION APPROACH TO BLACK SPOT IDENTIFICATION PROCESS
– A Case Study in Thailand –

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(Received October 6, 2005)

A black spot treatment program is one type of safety improvement program that can deal with accident occurrences reactively. However, implementation of such program requires relevant accident data, which are normally unavailable or limited in developing countries. Thus, this paper proposes a supportive approach (public participation approach) to overcome this hindrance. The objective is to demonstrate how a public participation approach can be used to assist in identifying black spot locations through the framework of an Accident Public Participation Program (APPP). The real world applications of such a program are presented through a selected case study in Khon Kaen City, Thailand. By contrasting the findings obtained from the proposed framework with those obtained from the classical approach in this field, feasibility, validity, and effectiveness of the program are revealed. The findings indicate statistically significant agreements between the two datasets. This implies that residence can identify locations where accidents occurrences are unusually high and their input is potentially useful for the identification process. In addition, besides the indirect benefits to creating public awareness, the proposed methodology is potentially useful as a means for both speeding up and economizing the black spot locations identification process. The paper is unique because the merits of several professionals in fields such as social science, engineering, and medicine are harmonized to achieve success in a safety improvement program.

Key Words: Accident data, Black spot locations, Developing countries, Public participation, Thailand

1. INTRODUCTION

Of all the systems with which people have to deal everyday, road traffic systems are the most complex and the most dangerous[1]. Road accidents are considered as one of the top three public health problems in Thailand[1]. Despite the Government's best efforts in recent years, unfortunately there are still over 13,000 deaths and more than one million injuries each year as the result of road accidents, with several hundred thousand people disabled[1]. It was estimated that the economic losses due to road accidents in Thailand are over 100 billion baht (approximately US$2.5 billion) per year, or about 3.4% of the country's GNP[2].

Lessons learned through the developed countries have made it evident that a black spot treatment program is an effective, reactive means for dealing with the occurrence of accidents. Also, the Thai government has introduced this program as one of the government's safety programs to help curb road accidents in the country. To implement such program, the first and most important step is to identify the site for safety improvement. While qualified historical accident data are needed for this process, lack of in-depth and detailed information on traffic accidents in Thailand are unfortunately widely acknowledged. An overall picture of the traffic accident situation in Thailand is often represented by police statistics mainly because of police are an agency responsible for collection and compilation of accident data throughout the country. Presently, the available statistics are the number of fatalities, number of injuries and property damages[3]. The efficiency of this routine data collection system, however, is widely questioned. As a result, the success of the implementation of black spot treatment program in Thailand has been hindered by data availability, timeliness and data quality issues.

To overcome these problems, this paper, therefore, intends to introduce a supportive approach for identifying black spot location, which is to employ public participation tactic. An attempt is made to illustrate how a public participation approach can be used to assist in identifying black spot location through the proposed framework of an Accident Public Participation Program (APPP). The real world applications of such a program are presented through a selected case study in Khon Kaen City, Thailand. By contrasting the findings obtained from the proposed framework with those obtained from the 'classical approach' in this field, feasibility, validity, and effectiveness of the program can be revealed.

This paper is organized as follows. In Section 2, some supportive reasons to employ public participation tactic to identify black spot location including previous activities to incorporate public input in safety analysis are addressed. Section 3 exhibits the research approach through the proposed Accident Public Participation Program (APPP). Section 4 presents the identification of black spot locations in the selected study area through the 'classical approach' namely the Rate Quality Control Approach. To demonstrate the real world application of the proposed framework of APPP, its case study is presented in Section 5. Finally, Section 6 presents the findings of this paper.

2. LITERATURE REVIEWS

2.1 What is a black spot?

In general, identification of the site with potential safety problem is the first and important step in the accident mitigation process. The technique to determine whether a site has a safety problem varies from place to place and is referred to by different names. Methodologies vary from the simple flag sites that have high-accident records to the more complicated ones of which the expected number of accidents is estimated and potential for safety improvements is determined. However, the most widely used technique to determine whether a site has a safety problem, is based on the road accident history and this is known as determination of 'Black Spot Locations'. Also, the whole accident mitigation process is often referred to as Black Spots Improvement.

Identification of black spots is a procedure to locate such spots within the road network. In reviewing the literatures, several methods are found for black spot determination that have been researched and proposed over past decades. Nevertheless, for practical ability, in many countries, the black spot definition is stated very simply. For an example, in Australia, the definition[4] of the black spot is given as:

> *'for individual sites such as intersection, mid-block or short road section, there has to be a history of at least 3 casualty crashes in any one year, or 3 casualty crashes over a three year period; 4 over a four year period; 5 over a five year period, etc. For lengths of road, there must be an average of 0.2 casualty crashes per kilometer of the length in question over 5 years; or the road length to be treated must be amongst the top 10% of sites with a demonstrated higher crash rate than other roads in a region [4].'*

Thailand has yet to adopt officially a method to identify black spot locations or even an official definition of black spots. However, in 1999 the Ministry of Transport and Communications commissioned the SweRoad of Sweden together with local consultants to carry out a comprehensive road safety project in Thailand[5]. Among various proposed strategies, black spot improvement program is also presented. The study team defined a black spot as a location where many accidents have occurred and/or the risk of being involved in an accident is high, and the risk of being injured in an accident is high. A black spot may be an intersection, or a section of road, or any other location that fulfils the definition. The team proposed the Rate Quality Control Method as a means to identify the black spot locations in Thailand. The logic of this method is that a location is considered to be a black spot if its safety parameter shows higher values than the critical value. They assured control of the quality of the analysis by applying a statistical test. There are three different parameters proposed in their study; accident rate, accident frequency, and accident severity.

However, this research focuses mainly on the accident frequency approach because it provides an advantage in terms of practicality. From the accident frequency point of view, a road section is considered to be a black spot, if:

$$A_j > A_c \text{ where } A_c = F_{ave} + k_\alpha \sqrt{F_{ave}/L_j} - 0.5/L_j \qquad \text{Equation 1}$$

Where A_c is the critical value for accident frequency.
L_j is the length of the road section.
F_{ave} is the average accident frequency for all road sections.
k is the statistical rate factor with specified significance level (e.g. for a confidence level of 95 percent, k is equal to 1.645).

2.2 Why bother with the public?

Public Participation has long been established for laws, regulations, and guidance issued by government agencies in the developed countries. The practice is intended to increase the efficiency and productivity of transportation plans and programs. For a black spot improvement program, besides supporting for a lack of accident data, there are several other distinct advantages to involving public in the identification process. The following discussion offers four supportive reasons why public participation should be emphasized in such program.

The first, and most obvious, reason is that road safety is a multi-disciplinary problem that requires various disciplines to develop the road safety activities effectively. In other words, the different expertise systems have to be merged together to give more insight in the new dimensions of safety problems. The widely known contributing factors deduce to road accident involve human factor, vehicle factor, road and environment factor. Although safety expert has understanding of the principle of safety science including the last two factors, they often have limited understanding on social culture and human behavior. As such, to ensure that the first and the most important factor is addressed, it is important to capture the feeling and assessment of the road safety situation from the viewpoints of the road users themselves. Encouraging public inputs can help agencies reach better decisions, as it will help the agency to identify locally problems that can lead to appropriate solutions.

The second reason to bother with public participation is referred to 'the sharing responsibility concept'. Under this concept, responsibilities should be shared between all of the players involved in the system to reach the optimum goal – which is to increase the social welfare through the reduction of the number of severe accidents and the feeling of insecurity. When black spot program is accomplished, the community would be the target of these distributed benefits. On the contrary, they also suffer the consequences of the inefficiencies of the program. Therefore, public as the major stakeholders, should bare responsibility in the program.

The third reason to bother with public participation is that the program is more likely to be accepted and supported by community members as they may feel that they have an active role in shaping the decision. They do increase trust in the process.

Other than the acceptance and support by the community, the fourth reason in encouraging public input is that it can create much awareness and more concern on road safety throughout the society. In continuation, people will regard their rights and obligations in the traffic safety. They will not only consider road accidents as a problem of driver's behavior but realize as a complex problem that can be solved. This may change the traditional believe of 'accident is an act of God' to 'accident is a problem but can be solved'.

Here the belief is that the social science together with engineering science can work closely to develop a program successfully. Since each has its merits and pitfalls, merits will be combined to design black spot programs comprehensively, effectively, and efficiently.

2.3 Some facts about public participation in Thailand

To propose public participation as a means of making Thai roads safer, it is important to review the existing public participation practices in the country. In Thailand, in spite of the fact that the government still places less emphasis on public participation in transportation planning process, the private sector particularly NGOs, on the other hand, has already implemented various public participation activities, especially road safety related activities.

The first public involvement in road safety example is rather typical as normally practiced in other countries. Citizens send the complaint letters and/or informing messages to the available mass media channels. They send these letters to the newspaper editor, to the television program, or post a massage on web-board expressing their feeling/idea towards any unsafe intersection, street, location, etc. Example of such letter is illustrated as shown in Figure 1. Although, substantial numbers of these letters are sent to the newspaper editor, only few are published and very few of these published letters are responded by the related agencies.

(Translation version)
1 November 2002

The Klong Teng villager wrote to us that the road accidents always occur at the section between Susco gas station and Esso gas station on the Patkasame Road. More than ten accidents occur in some months. Deaths and property damages seem like the usual event. Local people revealed that this is due to the road is four lanes highways without median, and two gas stations are located closely together so there are a lot of vehicles coming in and out all day. Moreover, the vertical curve posted before the two gas stations limits the driver sight distance. Consequently, when a speeding car comes to this area, the accidents always occur. We are told that responsible road agency will install the rumble strips to slow down the traffic. Nevertheless, for better result, the police officer should take a close look at this…

Fig. 1 Traditional inform/complaint letters

In Bangkok, the capital city of Thailand, incident occurrences are broadcast live via some radio stations. Actually, these radio stations are set up to report city traffic around the clocks (24-hr. reporting). However, number of callers also call and report on the incident occurrence to these radio stations. Most of these callers are drivers including taxi drivers. They called to inform other drivers to try to avoid such incident occurrence routes as well as to request for the emergency services to assist the accident victims. This example of public involvement has been existing during the past 10 years or so. It is interesting to note that certain radio station has no advertisement to cover its expenditures. Such station receives donations to pay for all expenditures including station rental fees, salaries, etc. This reflects the good practice of some citizens who are willing to contribute to society.

In Thailand, the NGO or charity foundation plays a major role in post crash management throughout the country. There exist several foundations who volunteer to pick up corpses caused by accidents and any other disaster events. They operate every day in twenty-four hours basis. In fact, often foundation staff is normally the first team to arrive at any accident scene, not the policemen. Their activity is also involved in initial first aids and transfer victims to the nearby medical cares. Often time, they are also working as the Emergency Medical Service team.

During the recent tsunami disaster in 2004, one good practice did occur during this tragic event which is the way Thais are helping each other. In the days following the tsunami, several volunteers came from all parts of the country to the effected area to support the local people as they recover from this terrible disaster. All these mentioned activities indicate that the interest of Thai people is not limited to improvement of their safety and living conditions but also in the lives of other people as well. Having mentioned these facts, there is a strong potential to involve the public in assisting to alleviate road safety problems in Thailand. Therefore, a public participation approach to assist in identifying black spot locations in Thailand is proposed and adopted for this study.

2.4 Previous activities to incorporate public input in safety analysis

In reviewing the literatures, although objective data such as police-report crash data have been used in several studies, relatively few researchers have explored incorporation of subjective data such as public input into the safety analysis processes. For example, in 1999, Caldwell and Wilson[6] used a mail-out safety survey of local road users to assist in identifying safety improvement needs for the rural unpaved roads. In their study, results from survey were validated against those from the safety audit process. The study found that the user safety survey accurately matched most of the specific needs identified in the safety audit. Findings also implied that the users identified weather-related conditions that primarily affect safety and were not identified by the safety audit procedure.

Although there is evidence of a connection between subjective data and objective data in the afore-mentioned research, in 2004, Schneider et al.[7] explored the discrepancies among them. In their work, two data sets, which were a set of police crash reports and a set of pedestrian and driver perception surveys, were used to identify the location in a campus area for safety improvement. Distributions of the perceived risks and the police-reported crashes were compared spatially. Findings revealed that the two distributions are statistically significantly different, implying that certain locations are perceived as dangerous, but actual pedestrian crash has yet to occur and vice versa. However, they concluded that the perception data could be used to identify pedestrian problems and to help select locations for proactive safety treatments.

The afore-mentioned studies describe different efforts to integrate perception data to evaluate road safety subjectively. Despite discrepancies among their findings, it can be concluded that the perception data provided valuable information about potentially safety improvement locations. This idea was also supported by Fitzpatrick et al.[8] who stated that citizens frequently could be an excellent means of identifying potentially hazardous locations. Their subjective feeling is always very useful information especially when the previous accident data is not available or is limited for a site. Therefore, this paper incorporates public input in the black spot identification process.

3. ACCIDENT PUBLIC PARTICIPATION PROGRAM (APPP)

Considering needs for black spot treatment, problems of lacking of accident data, distinct advantages of participation concept, and feasibility to incorporate public input into safety analysis, this paper then aims to encourage individual road users and public to participate in the identification of black spot locations through the development of the Accident Public Participation Program (APPP). APPP aims to provide the accessibility for the public/road users to inform/report the locations with poor

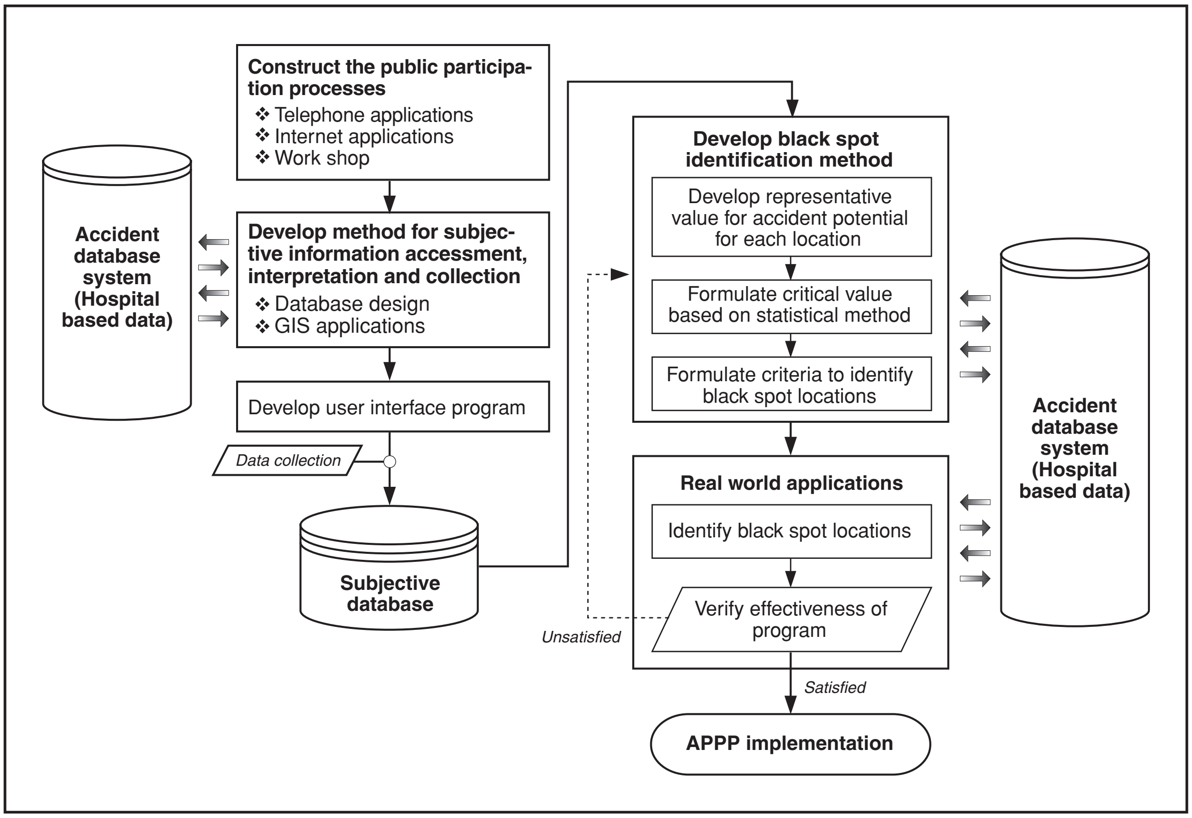


Fig. 2 Accident Public Participation Program methodologies

safety performance according to their feeling and experience. All road users such as driver, motorcyclist, pedestrian, etc are encouraged to participate in this program.

The following sub-sections present the conceptual framework of the developed APPP and also demonstrate how the public participation approach can be used to assist in identifying black spot locations. The overall methodology of APPP is graphically shown in Figure 2. Key procedures involved are addressed in the following sub-sections.

3.1 Participation process

As shown in Figure 2, the first step of APPP is to construct the public participation process. Since APPP aims to provide the accessibility for the public/road users to inform/report the unsafe location, the effective participation method is very important.

Presently, there are several public participation tactics practiced in Thailand. Each technique has both benefits and limitations. However, taking into consideration problem characteristics and existing implementation, the regular public informed information continues to offer the excellent tool for public involvement. As such, one of the approaches to capture public input is through the regular public informed information. Considering sustainability of the program, the central centre should be set up to directly receive the public inputs. The accessible methods such as telephone call, WWW., and postcard/letter should be provided for the road users to inform any potential hazard accident locations. For easily access and the most convenient, the direct line uses four-digit number, like 1666 for emergency service line, could be set up and announced to the public. The web page could be constructed for the public to inform this information. This proliferation of information technology applications is creating new opportunities and new demands on the public involvement process[9, 10].

While the first approach offers the advantage in terms of the sustainability of the program, it has a limitation in terms of timeliness, as its data collection required a long period of time. To speeding up the process, other public participation tactics such as the round table meeting, opinion surveys, focus groups, workshops, public hearings, etc can be considered. A variety of these approaches is almost sure to be more helpful than reliance solely on one of these measures[11]. Through the mentioned approaches, the special event can be held to gather the information from the pre-defined stakeholders. The 'traffic people' such as policemen, engineers, officers, all road users, media reporters, public health personnel, as well as the general public should be invited to join the interactive event.

3.2 Information management

The valuable public inputs from the earlier stage should be organized and processed in an established manner so that it is effective. A database management system can play a major role in gleaning information from the gathered data. The Geographic Information System (GIS) and database software should be used to execute the database. This will provide the capability to store data, update data, retrieve data, compare data and spatially display the data through GIS.

3.3 Identification method

In order to avoid biased results, as the obtained information are gathered in the subjective manner, it is important to construct a process to transform this subjective road safety information into a quantifiable data through a representative value. To achieve this, a safety index is required. One such available technique is the statistical quality control method. This method can be applied to formulate a critical value. Locations are identified as black spots if their safety index is greater than the formulated critical value.

3.4 Program validation

Questions concerning the reliability and the accuracy of the findings arise whenever one considers public inputs, which consists of perception data gathered in a subjective manner. Since the black spot locations identified via APPP are based on a subjective approach, the effectiveness of the program requires validation. The actual accident data or objective data available is employed for verification. The black spot locations identified via APPP is validated against those identified via a conventional method based on objective accident data.

4. BLACK SPOT LOCATIONS IN KHON KAEN MUNICIPALITY

As the proposed methodology needs validation, it is important to identify the black spot locations in the study area based on the classical approach and used for the comparative study. Therefore, in this section, the classical approach namely the Rate Quality Control Method is used to identify the black spot locations in the selected study area, Khon Kaen Municipality. This city is selected as a case study based on two main reasons. A first reason is the availability of the historical accident data to identify the black spot locations. Unlike other cities where lacks of accident data are acknowledged, in this city, a rich source of accident data is provided by the Khon Kaen Regional Hospital (KKH) through its Trauma Registry Database. A second reason is the availability of previous researches, which provides a resources base for future development of research and applications. In this city, Ruengsorn et al.[12] initiated a GIS road accident database system. Through the developed systematic linkage between road data and injury data in the GIS environment, any accident analysis based on Trauma Registry Database can be performed spatially.

To identify the black spot locations in Khon Kaen Municipality, data used are the 3-year accident reports recorded in the KKH's database during the period of 2001 to 2003 including the total numbers of 4,089 accident cases. Although this source of data can be considered as the richest source of accident data in Thailand presently, to effectively make use of this data, it should be noted there are two public hospitals in the study area. It is reasonable to make an assumption that the victims would normally be sent to the nearest hospital. Therefore, some accident occurrences may not be included in the KKH database and therefore are excluded from the analysis.

To perform the analysis, the road network in the study area is divided based on Link Recognition Technique[12] into two categories, i.e. intersections and sections. The total 75 kilometers road network including main arterial, arterials, and collector roads, are divided into 96 intersections and 192 road sections. To facilitate the task to determine number of accidents occurred on each intersection/road section, the computer package as shown in Figure 3 is developed. Series of command are customized by the Avenue, the programming language that is attached with ArcView software. The package is presently used by the KKH staff to monitor and reported the safety situation in the provincial level.

The total number of accidents that occurred on the intersections and road sections were 1,476 and 2,613 accident cases, respectively. Based on the Rate Quality Control Method, certain intersection/road section is identified as a black spot location if its accident counts are higher than the critical value calculated from Equation 1. Consequently, it is found that 28 out of 96 intersections and 65 of the 192 road sections have been identified as black spot sites. Figure 4 reveals the spatial distributions of the identified intersections and road sections in Khon Kaen City.

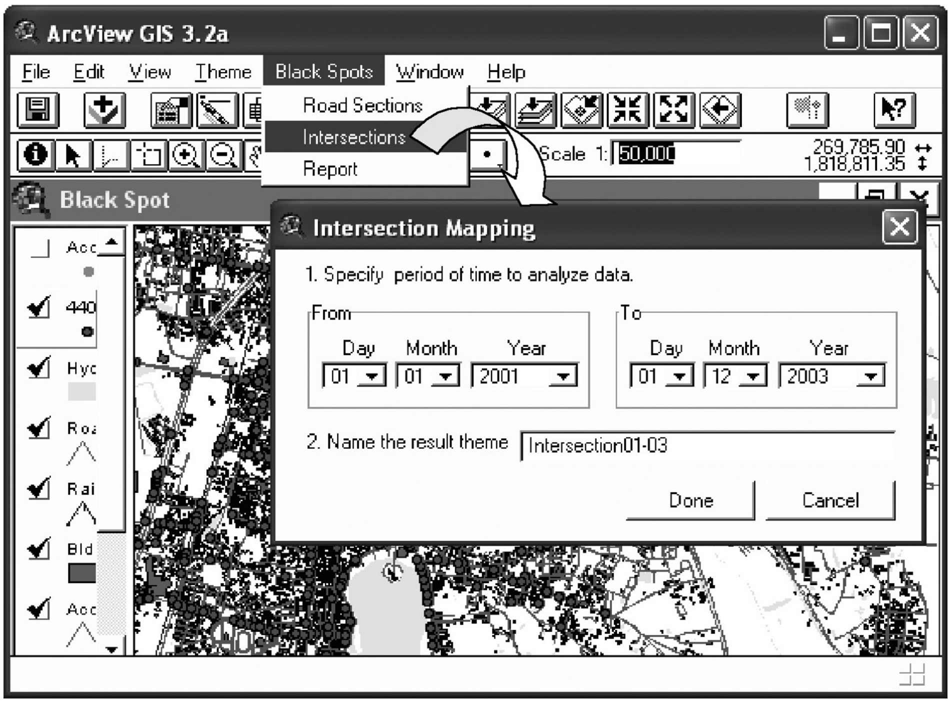


Fig. 3 Back spot locations package

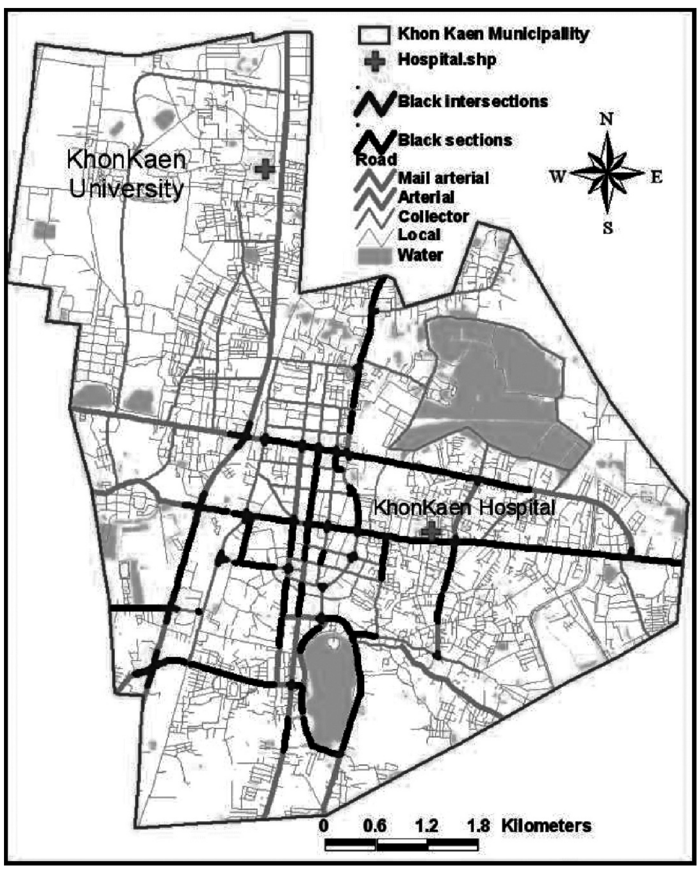


Fig. 4 Black spot locations identified via Rate Quality Control Method

5. APPP CASE STUDY

After developing the conceptual framework of APPP, a case study was conducted to demonstrate the proposed technique. To initiate the process, a seminar entitled 'Public Participation in Black Spot Identification Process' was held in the selected study area. The program included presentation of the accident situation in the city, engineering means to alleviate road safety problems, view points of a medical expert, and a panel discussion. The participants represented various stakeholders including public sector, NGOs, community leaders, local officials, academicians, and private sector attended this seminar.

To capture the public input, a questionnaire survey was distributed during the seminar. The questionnaire survey technique was selected to meet the time constraints involved. The participants were asked to identify sites with road safety problems in the municipal area based on their own perceptions and to fill in the open-ended questionnaire. Participants were also encouraged to provide comments and suggestions about the APPP. Finally, 70 unsafe locations in the Khon Kaen Municipality are reported in the questionnaires. These 70 unsafe locations (referred to as APPP Data) are documented and plotted into a digital map of the study area. The large-scale digital map composed of well-prepared road database and useful landmark information, facilitated the process of site identification[12]. These APPP data and the total of 4,089 accident cases as recorded by the KKH during the period of 2001 to 2003 (referred to as KKH Data), are displayed spatially as shown in Figure 5.

Although the case study is conducted under time constraints and with a limited amount of input data, its results are satisfied. Following sub-sections reveal the validity of the APPP program through the comparison between the public input data (APPP data) and the historical accident data (KKH data).

5.1 Spatial distribution comparison

Since all data are well prepared in the desired format, their spatial clusters can be identified through the Kernel Density Estimation technique[7] attached to GIS software. A Kernel density map, as shown in Figure 6A, can reveal the clusters of APPP data. Besides, clusters of

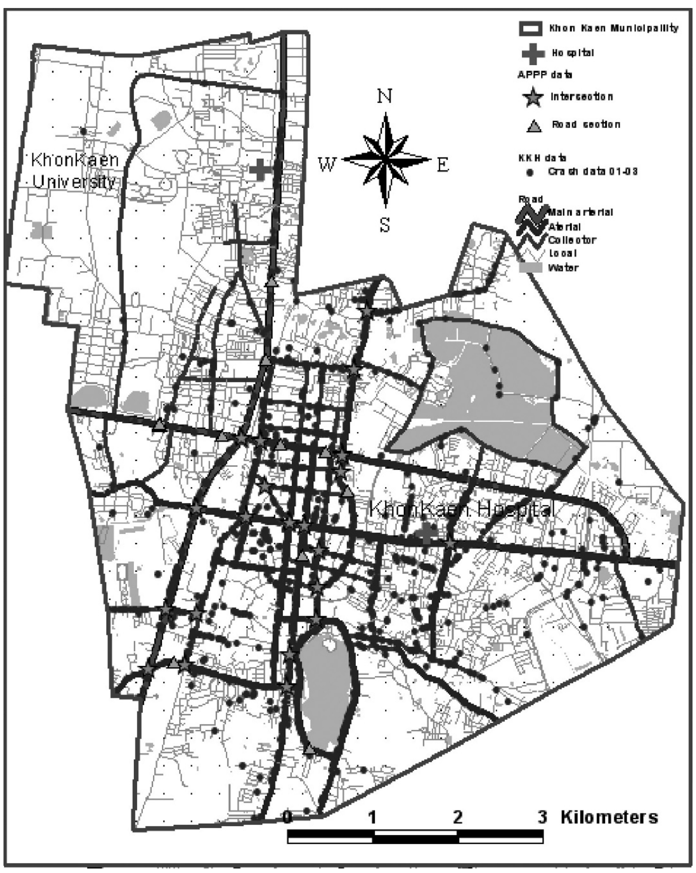
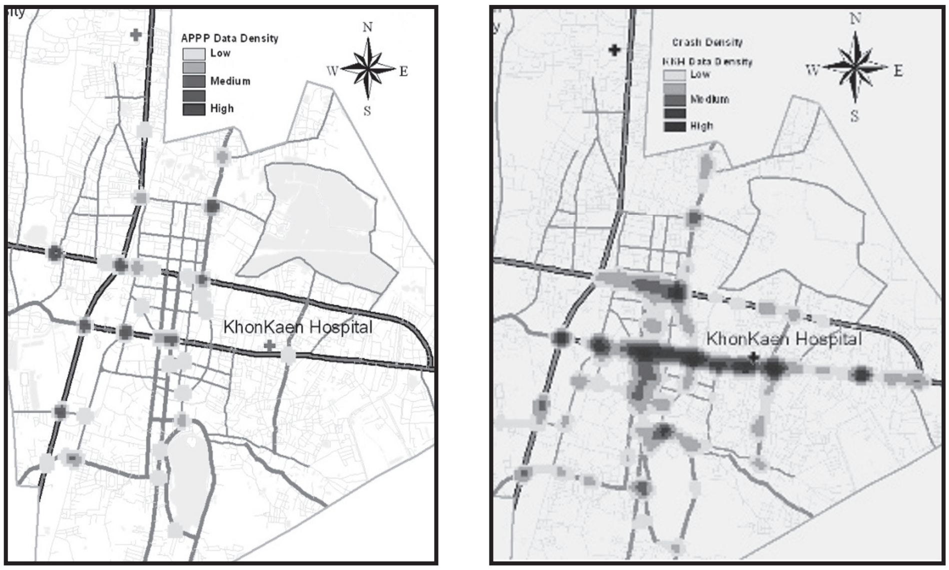


Fig. 5 Spatial distributions of KKH data and APPP data



(A) APPP data **(B) KKH data**

Fig. 6 Kernel density map of APPP data and KKH data

KKH data are also created as shown in Figure 6B. As can be seen from this figure that the high crash-density areas are distributed throughout the study area except in the Northwest part of the municipality. This is due to the fact that there is another public hospital located in this area. Therefore, it is likely that patients involved in those accidents in the Northwest part are admitted to that hospital and are not recorded in the KKH's database. Nonetheless, comparing the distributions as shown in Figure 6 reveals some connections between the dark areas represented the high data density particularly at locations where victims should be sent to the KKH. This indicates the matching between the public reported locations (APPP data) and the actual (high) accident occurrence locations (KKH data). In addition, in some locations where historical accident data is degraded (e.g. in the Northwest part of the municipality where the victims should be sent to another hospital), the APPP data may be useful as a supplement data to the available historical accident data.

5.2 Statistical test

Although a visual comparison in the previous subsection shows that there are agreement between the historical accident data (KKH data) and APPP data. This visual assessment must be supported by statistical method to reveal whether the agreements are legitimate. The Spearman rank correlation coefficient is used for this comparison. The Spearman rank correlation coefficient is often used as a nonparametric alternative to a traditional coefficient of correlation and can be applied under general conditions[13]. To calculate the Spearman rank correlation coefficient, it is necessary to segment the data sets and then rank the paired data sets in ascending or descending order[13].

Computer package mentioned in Section 4 is used to determine the number of matched KKH data and APPP data for each intersection and road section. The findings are as shown in Table 1. Also the ranks are established based on descending order for KKH data and APPP data both in terms of count and count per meter. The paired datasets are then used in calculating the Spearman rank correlation coefficient (ρ_s) as shown in Equation 2. The results will always be between 1 (a perfect positive correlation) and -1 (a perfect negative correlation) and a value near zero indicate no relationship.

$$\rho_s = 1 - \frac{6\sum d^2}{n(n^2-1)} \qquad \text{Equation 2}$$

Where d is the difference between ranks and n is the number of paired sets.

Under a null hypothesis of no correlation, the ordered data pairs are randomly matched and thus the sampling distribution of ρ_s has mean of zero and the standard deviation (σ_s) can be determined using Equation 3[13].

$$\sigma_s = \frac{1}{\sqrt{(n-1)}} \qquad \text{Equation 3}$$

Since this sampling distribution can be approximated with a normal distribution (N(0,1)) even for relatively small value of n., this approximation leads to a conve-

Table 1 Summary of KKH data and APPP data on segmented road network

No.	ID Number	Length (m)	KKH data (Historical Accident Record) Count	Rank (1)	Count/ Length	Rank (2)	APPP data (Public input data) Count	Rank (3)	Count/ Length	Rank (4)	Rank Difference (1)-(3)	(2)-(4)
1	0005	1218	42	24	0.0345	29	1	23.5	0.0008	32	0.5	-3
2	0010	493	59	23	0.1196	23	4	5	0.0081	15	18	8
3	0015	691	116	14	0.1680	22	4	5	0.0058	22	9	0
4	0020	554	60	22	0.1083	24	4	5	0.0072	18	17	6
5	0050	150	186	9	1.2361	11	2	11	0.0133	9	-2	2
6	0070	176	148	12	0.8401	15	3	7.5	0.0170	6	4.5	9
7	0105	531	109	16	0.2053	20	5	2.5	0.0094	12	13.5	8
8	0110	151	299	4	1.9865	5	2	11	0.0133	10	-7	-5
9	0115	150	314	2	2.0986	4	3	7.5	0.0200	4	-5.5	0
10	0135	215	289	5	1.3450	9	1	23.5	0.0047	25	-18.5	-16
11	0150	142	176	11	1.2418	10	1	23.5	0.0071	19	-12.5	-9
12	0155	130	8	31	0.0617	26	1	23.5	0.0077	16	7.5	10
13	0310	137	29	27	0.2119	19	1	23.5	0.0073	17	3.5	2
14	0360	142	226	7	1.5935	7	5	2.5	0.0353	1	4.5	6
15	0370	132	182	10	1.3799	8	2	11	0.0152	7	-1	1
16	0405	83	96	19	1.1518	12	2	11	0.0240	3	8	9
17	0500	138	333	1	2.4081	2	2	11	0.0145	8	-10	-6
18	0520	86	301	3	3.4844	1	1	23.5	0.0116	11	-20.5	-10
19	0545	107	113	15	1.0597	13	1	23.5	0.0094	13	-8.5	0
20	0690	111	0	33	0.0000	33	1	23.5	0.0090	14	9.5	19
21	0770	29	69	21	2.3744	3	1	23.5	0.0344	2	-2.5	1
22	0001060000	967	6	32	0.0062	32	1	23.5	0.0010	31	8.5	1
23	0001080000	1533	10	30	0.0065	31	1	23.5	0.0007	33	6.5	-2
24	0002030000	869	34	25	0.0391	27	6	1	0.0069	20	24	7
25	0002040000	659	23	28	0.0349	28	1	23.5	0.0015	28	4.5	0
26	0003070000	431	138	13	0.3199	18	1	23.5	0.0023	26	-10.5	-8
27	0003090000	211	99	18	0.4687	17	1	23.5	0.0047	24	-5.5	-7
28	0007020000	908	18	29	0.0198	30	1	23.5	0.0011	30	5.5	0
29	0007110000	188	189	8	1.0034	14	1	23.5	0.0053	23	-15.5	-9
30	0013010000	51	32	26	0.6322	16	1	23.5	0.0198	5	2.5	11
31	0022050000	147	238	6	1.6216	6	1	23.5	0.0068	21	-17.5	-15
32	0024010000	506	99	17	0.1958	21	1	23.5	0.0020	27	-6.5	-6
33	0026050000	731	79	20	0.1081	25	1	23.5	0.0014	29	-3.5	-4
						Spearman rank correlation (ρ_s)					0.363	0.668
						Standard deviation (σ_s)					0.177	0.177
						Calculated Z-value					2.055	3.779

nient form of a test for independence[13,14]. The null hypothesis of no correlation is rejected if:

$$\rho_s \sqrt{(n-1)} \geq Z_\alpha \qquad \text{Equation 4}$$

Where Z is the upper point of a standard normal distribution[14].

With n equal to 33, the standard deviation (σ_s) is calculated to be 0.177. On the count basis, Spearman rank correlation coefficient (ρ_s) is calculated to be 0.363. The calculated z-value is 2.055 which is higher than the critical z-value of 1.96 representing the 97.5% level of significant. For the count per meter, Spearman rank correlation coefficient (ρ_s) is calculated to be 0.668. The calculated z-value is 3.779 which is higher than the critical z-value of 2.33 representing the 99% level of significant.

The results from the correlation analysis indicate that the ranking from the two dataset agreed at the 97.5% and 99% level of significance on the count basis and count per meter basis, respectively. The findings in this sub-section provide further evident of the agreement between the two data sets.

5.3 Black spot location comparison

To verify the effectiveness of APPP, the black spot locations identified via APPP and those identified via classical methods are compared. In view of the APPP data, a total of 70 unsafe locations gathered through the questionnaire consist of 22 road sections and 49 intersections. Considering the locations identified as black spots by one or more people, then there are a total of 33 such locations; by two or more respondents, there are13; by three or more, 8; and, by four or more, 6 black spot locations, respectively. These findings are summarized as shown in Table 2.

Comparing the findings in Table 2 with the black spot locations identified by the Rate Quality Control (Section 4), agreements among them are presented in Table 3. Considering these results together with the spatial distribution of locations identified via APPP, and physical characteristic of road network, the following findings can be presented:

- There were 26 locations, out of a total of 33, identified by one or more of the seminar participants, which are truly black spot locations. Of the 7 mismatched locations, 5 of them are road sections that located in the Northwest area. Other 2 mismatched locations are found at unsignalized intersections, as reported by one participant.
- Twelve out of 13 locations identified by two or more of the seminar participants are found to be actual black spot locations. The only mismatched location is in the Northwest area.
- Seven out of the 8 locations identified by three or more participants are found to be true black spot locations. The mismatched location was located in the Northwest area.

The findings reveal that most locations identified by two or more participants, are indeed black spot locations, and the evidence indicates that mismatches occurred mostly in the Northwest area. However, as earlier mentioned that crashes recorded in this area are incomplete, the mismatched locations may further help identify locations where accidents are not recorded properly.

5.4 Success of the pilot program

As presented in the previous sub-sections, it can be concluded that public can identify the black spot locations that are spatially matched with those locations identified through the historical accident data recorded in the KKH's Trauma Registry Database. Furthermore, mismatched locations have implications for crash prevention as it may provide proactive data to identify locations for further safety investigation. Mismatched location should be studied further to identify other dangerous components such as roadway conditions, physical characteristics, injuries pattern and motorist's behavior. If these analyses reveal that the mismatched location is abnormally dangerous, this will confirm the success of the proposed APPP concept.

Besides, the questionnaire result reveals that most of the respondents agreed with the APPP concept. It reveals their strong attitude in supporting this program. Respondents found the program useful and worth being implemented in their community. Thus, it can be said that there is a strong potential for successful implementation of the full APPP in the study area in the near future.

6. CONCLUSIONS

While data is important, road safety activities cannot be completely data-driven especially in developing countries where accident data are limited and safety improvement activities are urgently needed. This paper, therefore, presents a supportive approach to identify black spot locations through public participation. The paper reviews the obstacles in implementing black spots treat-

Table 2 Number of black spot locations identified via APPP

		Pointed out by ≥1 people	Pointed out by ≥2 people	Pointed out by ≥3 people	Pointed out by ≥4 people
No. of Black Spot Locations Identified by APPP	Road sections	12	1	1	1
	Intersections	21	12	7	5
	Total	33	13	8	6

Table 3 Agreement of black spot locations identified via APPP and Rate Quality Control method

No.	ID	Type	Black Spot Location					
			APPP Approach					RQQ Approach
			APPP Count	Pointed out by				
				≥1 people	≥2 people	≥3 people	≥4 people	
1	0005	Signalized Intersection	1	B	-	-	-	B
2	0010	Signalized Intersection	4	B	B	B	B	B
3	0015	Signalized Intersection	4	B	B	B	B	B
4	0020	Signalized Intersection	4	B	B	B	B	B
5	0050	Signalized Intersection	2	B	B	-	-	B
6	0070	Signalized Intersection	3	B	B	B	-	B
7	0105	Round About	5	B	B	B	B	B
8	0110	Signalized Intersection	2	B	B	-	-	B
9	0115	Signalized Intersection	3	B	B	B	-	B
10	0135	Signalized Intersection	1	B	-	-	-	B
11	0150	Signalized Intersection	1	B	-	-	-	B
12	0155	Unsignalized Intersection	1	B	-	-	-	-
13	0310	Signalized Intersection	1	B	-	-	-	B
14	0360	Signalized Intersection	5	B	B	B	B	B
15	0370	Unsignalized Intersection	2	B	B	-	-	B
16	0405	Unsignalized Intersection	2	B	B	-	-	B
17	0500	Signalized Intersection	2	B	B	-	-	B
18	0520	Unsignalized Intersection	1	B	-	-	-	B
19	0545	Unsignalized Intersection	1	B	-	-	-	B
20	0690	Unsignalized Intersection	1	B	-	-	-	-
21	0770	Railway Crossing	1	B	-	-	-	B
22	0001060000	4 lanes, divided, w/o frontage	1	B	-	-	-	-
23	0001080000	4 lanes, divided, w/o frontage	1	B	-	-	-	-
24	0002030000	6 lanes or more, undivided w frontage	6	B	B	B	B	-
25	0002040000	6 lanes or more, undivided w/o frontage	1	B	-	-	-	-
26	0003070000	6 lanes or more, undivided w/o frontage	1	B	-	-	-	B
27	0003090000	6 lanes or more, undivided w/o frontage	1	B	-	-	-	B
28	0007020000	2 lanes, Roadway width > 6.0 m	1	B	-	-	-	-
29	0007110000	6 lanes or more, undivided	1	B	-	-	-	B
30	0013010000	2 lanes, Roadway width > 6.0 m	1	B	-	-	-	B
31	0022050000	2 lanes, Roadway width > 6.0 m	1	B	-	-	-	B
32	0024010000	4 lanes, undivided	1	B	-	-	-	B
33	0026050000	2 lanes, Roadway width > 6.0 m	1	B	-	-	-	B
	No. of locations truly identified by APPP data			**26**	**12**	**7**	**5**	
	No. of locations wrongly identified by APPP data			**7**	**1**	**1**	**1**	
	Total number of location identified by APPP data			**33**	**13**	**8**	**6**	
	Percent of truly identified			**78.8%**	**92.3%**	**87.5%**	**83.3%**	

ment in the developing countries as well as the reasons and the need for creating public partnership to identify black spot locations. This paper proposes a framework, called the Accident Public Participation Program (APPP) that uses the knowledge of community residents to assist in identifying black spot locations. A methodology to develop the APPP as well as the validation process are highlighted. How the public participation approach can be used to assist in identifying black spot site is demonstrated through a case study of Khon Kaen City, Thailand.

The feasibility, validity, and effectiveness of the program are evaluated by comparing the findings obtained from the proposed framework and those obtained from the classical approach in this field. The comparison results indicate that there are statistically significant agreement between the public input data and historical accident data. Therefore, it is a potential that the proposed method can be used as a supplement tool to identify the black spot location especially for the location where the accident data is degraded, limited or not available. In addition, besides the indirect benefits to creating public awareness, the proposed methodology is potentially useful as a means for both speeding up and economizing the black spot locations identification process.

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