

# BURGLARY RISK ASSESSMENT USING GEOSTATISTICAL ANALYSIS

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**ABSTRACT:** Crime has become worldwide problems causing damage to life and property. Burglary is one of crime aspects showing the highest number of crime scenes. Hence, Geographic Information System is designated to be employed in this study so as to discover the spatial relationship of burglary aspects. Banpong district, Ratchaburi province of Thailand was chosen as study area due to high levels of burglary incidents recently. The spatial relationship of robbery in sub-district scale was investigated using geostatistical analysis over the time of 2012 to 2014. The results of this research illustrate that burglary incidents over three years are distributed dispersedly as Moran's I of -0.01, -0.16 and -0.01, respectively. Hot spot analysis was further used to identify where high or low levels of crime scenes are arisen. The values of Getis-Ord  $G_i^*$  over study time were found as more than  $>1.96$ , describing three sub-districts of Banpong, Thapa and Nongoo are in high levels of crime scenes. Afterwards, Directional Distribution (Standard Deviational Ellipse) was carried out to find distribution pattern and trend of burglary incidents. It was discovered that the burglary scenes had been distributed in the central part of Banpong district and leaned towards eastern direction of the study area. Conclusively, the results retrieved from this investigation can enhance police agencies in planning, surveillance of robbery scenes and so forth.

## 1. INTROUCTION

Crime can be considered as a common problem globally which is relatively related to various factors. One among these factors is mainly associated with socio-economic problems. The impacts of crime have increasingly attributed to serious social conditions along with the development of technologies. Crime causes the damaging of human lives and their properties. Crime can also create mistrust feeling among social population. However, it is impossible to avoid the occurrence of crime in any society, but its occurrences can be prevented through the collaboration from every party in the community. In particular, population is a crucial factor in the prevention of crime. With this regards, watchful manner can help to maintain peace and social orders.

Thailand faces challenges causing by crime like other countries. Most often, crime associates with recession or economic crisis. Such condition will decrease the country's export (Bank of Thailand, 2015). This phenomenon forces many business enterprises to shut down or lay off their employees. It is a crucial factor that increases unemployment rates and affect the reduction of household earning income. The revelation of statistical number of unemployment rate between 2012 and 2011 explains that there is an increasing growth in unemployment percentage (Labor market Research Institute, 2015). This causes several criminal issues such as burglary, robbery, and stealing, snatching and other related crimes. According to the statistical report on crimes occurrence during 2014, it is found that highest crime rates occurred in the western part of Thailand for about 205,609 cases. These cases are often related to offensive actions or burglary with the intention to injure the victims and intend for the victims' properties about 47,090 cases (National Statistical Office, 2015).

According to previous literature, there are evidences showing that geo-statistical analysis in GIS has been used to enhance statistical interpretation in several aspects. Nakhapakorn and Suphet (2006) applied spatial autocorrelation statistics (Moran's I) to study the epidemic patterns of Dengue fever in Sukhothai province, Thailand. Jiratiwan (2006) studied the distribution patterns of Dengue fever in Nakhon ratchasima province, Thailand through the analysis of hot spots using Getis-Ord  $G_i^*$  technique. These are common tools to investigate epidemic pattern in the field of public health. Jeefoo (2014) investigated the analysis of spatial pattern of Diarrhea incidence in Phayao province, Thailand between 2009 and 2011 through the use of global geo-statistical analysis Moran's I and local geo-statistical analysis Getis-Ord  $G_i^*$  was used to find out the expansion of diarrhea along with identifying high and low rates of infected areas. Rossen, Khan, and Warner (2013) applied hot spots of the death occurrence related to drug consumption in the

United States between 2007 and 2009 using global geo-statistical analysis Moran's I to discover the distribution pattern of death occurrence and local geo-statistical analysis Getis-Ord  $G_i^*$  to find out the areas with high and low death occurrence. Woraya (2000) also studied crime expansion between 1996 and 1998 particular with aggravated assault for lives and properties in Bang Sue, Bangkok city with the use of nearest neighbor index. Monton and Manat (2010) used the Kernel density estimation for criminal pattern specifically murder, drug, stealing and snatching in Phranakorn, Bangkok during the time of 2003-2007. In this paper, Kernel density estimation was also carried out to measure hot spots of crime incidence. Kraisri (2013) analyzed crime occurrences in the southern province of Thailand focusing on gun shooting, bombarding and firing between 2012 and 2013 through the use of geo-statistics to explain the pattern of crime occurrence, the frequency of crime patterns and level of violence. Sakaorat (2013) discovered the patterns of skyscraper organization in Pattaya city through the use of directional distribution in order to study the directions of expansion in relation with geographical and socioeconomic aspects. Dissaphong (2015) examined the characteristics of suitable and special check points in Narathivas province, Thailand using directional distribution to find out the tendency of crime occurrence so as to allocate of check points and achieve in decreasing violence in this study area. Samphuthanon, Tripathi, Ninsawat and Duboz (2013) employed the technique of directional distribution as well to investigate the tendency of Hand foot and mouth disease in the northern areas of Thailand from 2003 to 2012. In this paper, we discovered that using geo-statistical analysis is common applied in the field of public health and crime study (Nakhapakorn and Jirakajohnkool, 2006). However, it has not been found that this method has been introduced for the study of crime related to burglary. With this regards, we therefore aims to integrate the technique of geo-statistical analysis of Moran's I, Getis-Ord  $G_i^*$  and Directional Distribution to study burglary which is considered to be the highest criminal issues in Thailand.

From the above evidence, the objective of this study is to implement the geo-statistical analysis to investigate the spatial relation of crime focusing on burglary. Crime pattern was examined in order to determine the areas with high and low crime occurrence. This research also studied the direction and tendency of crime expansion of burglary happened in Banpong district, Ratchaburi province, Thailand since Banpong is considered to be one of the areas with high crime rates in Ratchaburi. This district also has second highest population density in Ratchaburi province. (Banpong district office, 2015). Geo-statistical analysis tools can be used to investigate spatial relation in two levels (Jiratiwan, 2006) which comprise global level (to identify patterns of burglary incidents) and local level (to examine hot spots of incidence). With this regards, Moran's I technique was used for the analysis of overall crime patterns to explain the expansion of crime. The analysis of local level using Getis-Ord  $G_i^*$  tool was applied to discover the areas of high or low crime rates. This study is conducted using 3-year data between 2012 and 2014.

## **2. MATERIALS AND METHODS**

### **2.1 Study area**

Banpong district of Ratchaburi Province was chosen as study area due to its record of the second highest population in Ratchaburi; a western province of Thailand. (Banpong district office, 2015). This district has about 3,488,330 square kilometer where 15 sub-districts are situated as shown in figure 1 (Land Development Department, 2011). Banpong is one of large economic zone where several industries can be found. Most of industries are automobile industry and trade where large several types of transportation are produced (The largest automobile industry of Thailand). Banpong is also well-known for its largest fish village market, which is the largest fish market in Asia (Information Technology and Communication Group Ratchaburi, 2015). Banpong is known as southern and western gate of Thailand as well. These significant aspects benefit population in term of its convenient for transportation and exchanges.

### **2.2 Materials**

The data acquired from this research are followings; (1) the burglary incidence between 2012 and 2014 in document format, retrieved from Banpong police station. This data was necessary to be transferred into geographic information system so as to demonstrate crime occurrence points in geo-referenced format, and (2) Administrative data of Banpong with the scale of 1:50,000, received from Land Development Department.

### **2.3 Methods**

The methodologies of this paper are in threefold; (1) The data preparation of burglary incidence. (2) The analysis of spatial correlation on burglary cases using geo-statistical tools and, (3) Interpretation and visualization of spatial correlation on burglary cases analyzed by Geo-statistical analysis. Figure 2 presents the conceptual framework of this research.



2.3.3 Interpretation and visualization of spatial correlation on burglary case are divided into 3 parts; (1) the results from the technique called Moran's I describe the burglary expansion pattern of the study area. Moran's I value from 0 to +1 explains the expansion pattern of burglary cases. If the value is shown positively, the spatial correlation of burglary cases is identified as cluster relationship (from 0 to +1). On the other hand, negative value (from 0 and -1) describes spatial correlation in opposite or randomly distributed direction, and zero value shows no spatial correlation or uncertain pattern of burglary cases (Dale and Fortin, 2014). (2) The Interpretation of the results retrieved from Getis-Ord  $G_i^*$  analysis reveals areas with high crime rate ( $G_i^* > 1.96$ ) or areas with low crime rate ( $G_i^* < -1.96$ ) (Rossen, Khan, and Warner, 2013) and, (3) The results obtained from the analysis of Directional Distribution can be used to explain the tendency of burglary expansion of the study area.

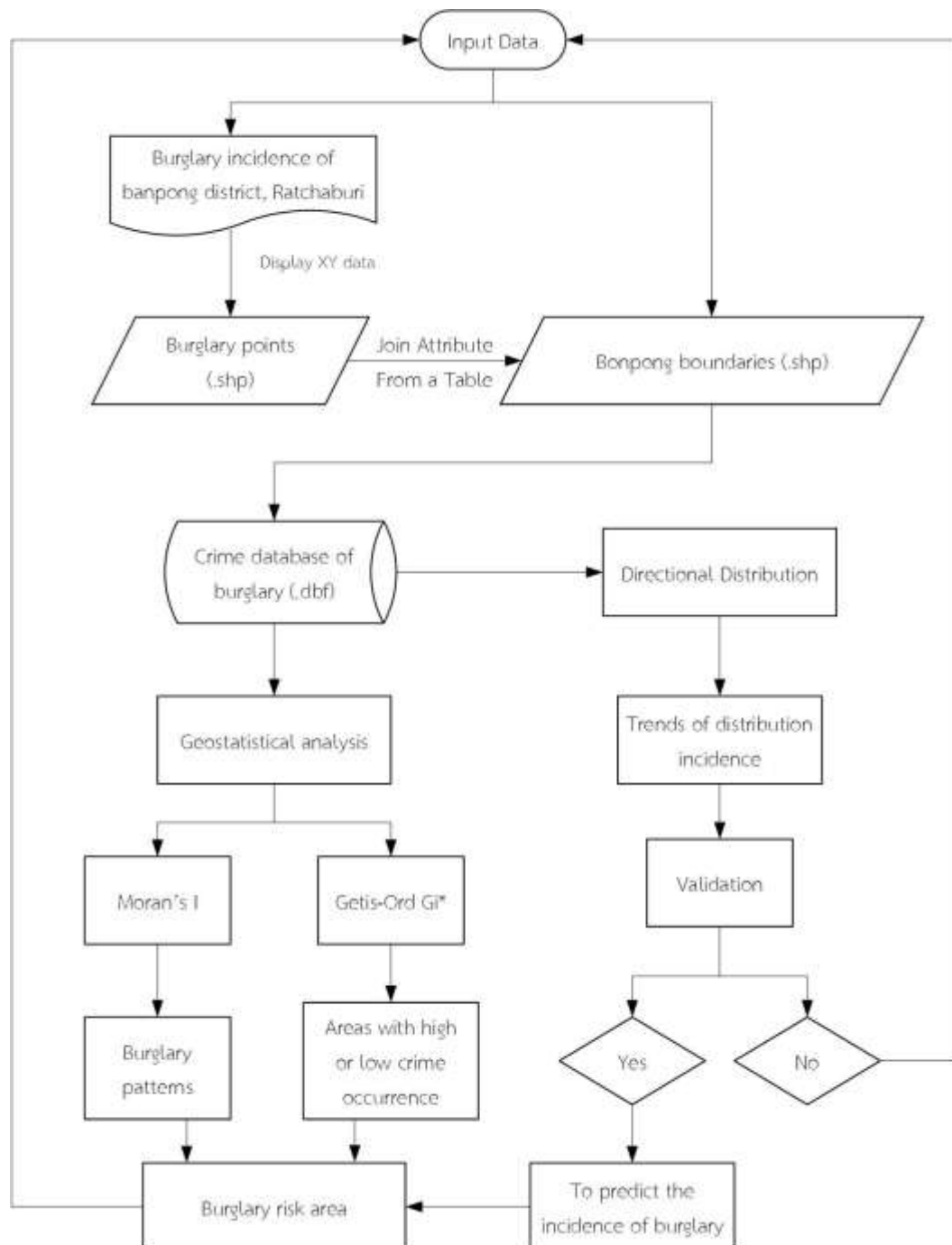


Figure 2 The Conceptual framework of the study

### 3. RESULTS

#### 3.1 Burglary Crime Patterns by Moran's I and Hot Spot Analysis using Getis-Ord $G_i^*$ Technique

The results of applying Moran's I to investigate pattern of burglary crime scenes show that burglary incidence of the study area with 3-year period is in randomly distributed direction. This can be explained by Moran's I negative scores found at -0.01, -0.16 and -0.01, respectively. The study of hot spots using Getis-Ord  $G_i^*$  in 2012 illustrated the area which has  $G_i^*$  more than 1.96 in 2 sub-districts; Thapa and Banpong as shown in Figure 3(a). The two areas are more developed in terms of social and environmental aspects in association with the highest population density of Banpong district. In 2013, it was discovered that the area containing  $G_i^*$  more than 1.96 is Nongoo sub-district, on the other hand, Banpong demonstrates  $G_i^*$  value between 1.65 and 1.96. Majority of Nongoo city is industrial areas causing increasing population density lead towards central immigration. Social imbalance can be seen as one of the crucial issues related to the immigration of industrial workers. The negative outcome from this condition can be seen in more incidence of crime as shown in Figure 3(b). In 2014 It was found that the sub-district displayed  $G_i^*$  more than 1.96 is Banpong, while  $G_i^*$  between 1.65 and 1.96 can be seen in Nongoo. It is suggested that more development in social and environment aspects contributed to highest population density in Banpong. This can be explained in Figure 3(c).

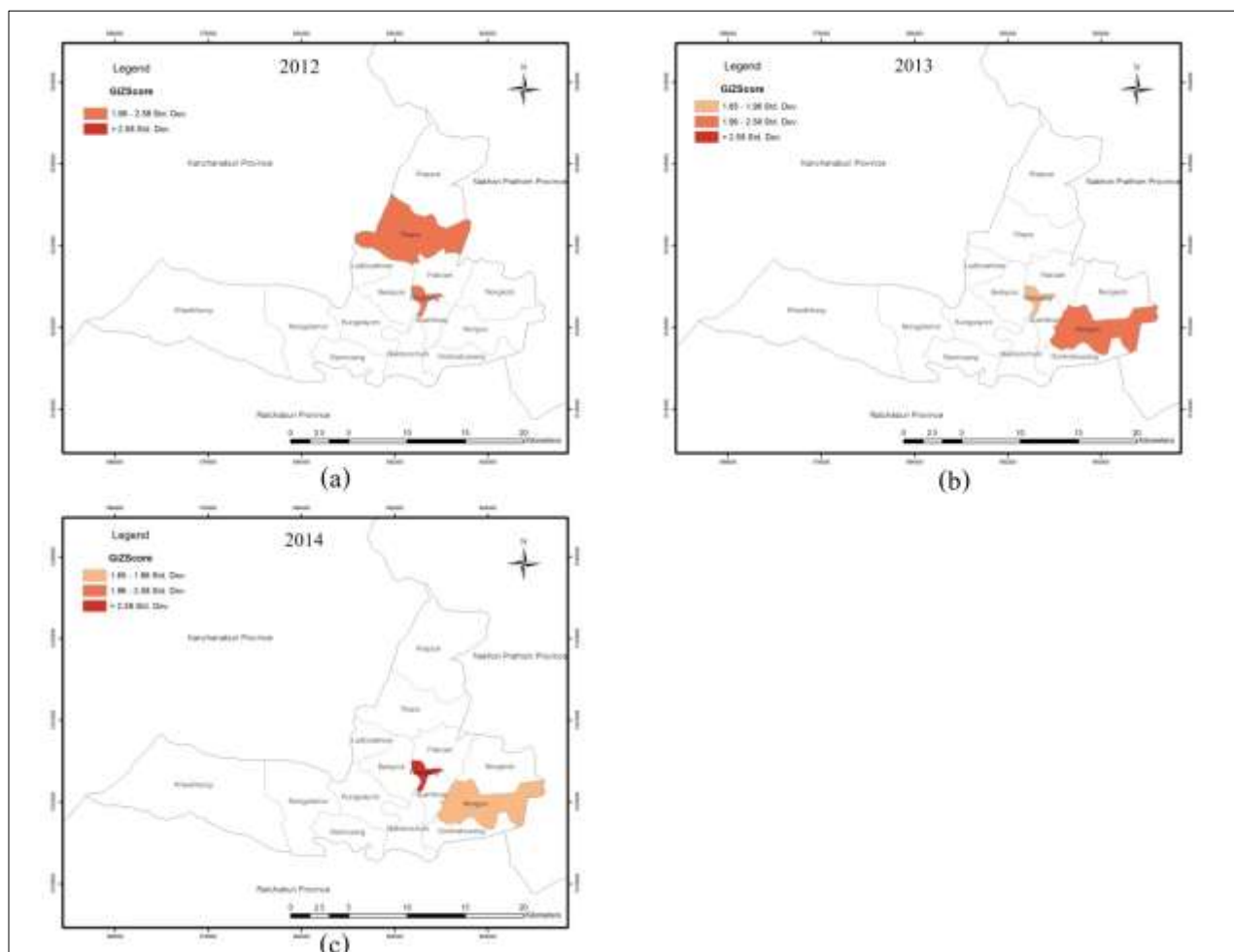


Figure 3 Hot spots of burglary incidence (a) 2012 (b) 2013 (c) 2014.

### 3.2 Burglary Expansion Direction

Directional Distribution analysis was employed to investigate burglary expansion direction so as to be used in prediction of burglary incidence. In this paper, it was found that burglary cases in 2012 were likely occurred towards eastern direction of the study area spreading throughout the sub-districts called Ladbaukhaw, Nongplamor, Berkprai, Pakraet, Kungpayom, Banpong, Saunkluay, Nongoo and Nongkob. Afterwards, the results of burglary expansion direction were taken to make a comparison with actual recorded burglary evidence of 2012 to carry out validation. In 2013, it was exposed that burglary scenes were likely happened towards eastern direction of the study area as same as in 2012. The burglary expansion direction was found in following sub-districts; Ladbau khaw, Nongplamor, Berkprai, Pakraet, Kungpayom, Banpong, Saunkluay, Nongoo and Nongkob. Likewise, the results of the analysis were validated to make a comparison with the evidence regarding burglary which has recorded in 2013. In 2014, burglary expansion direction was prospectively occurred from the eastern part then spread throughout the areas known as Ladbaukhaw, Nongplamor, Berkprai, Pakraet, Kungpayom, Banpong, Saunkluay, Nongoo and Nongkob. As mentioned earlier, the results of burglary expansion direction were validated actual incidence of 2014. The overall validation of burglary expansion direction each year was found significantly as shown in figure 4. This implies that burglary cases occur towards the eastern part of study area. Conclusively, since major area of Banpong is important economic and industrial areas attracting migrated workers, burglary crime rates are mainly found. Moreover, crime scenes are often committed as a burglary are likely to be found more in the eastern part spread through roughly in the middle sub-district of Banpong and the nearby areas.

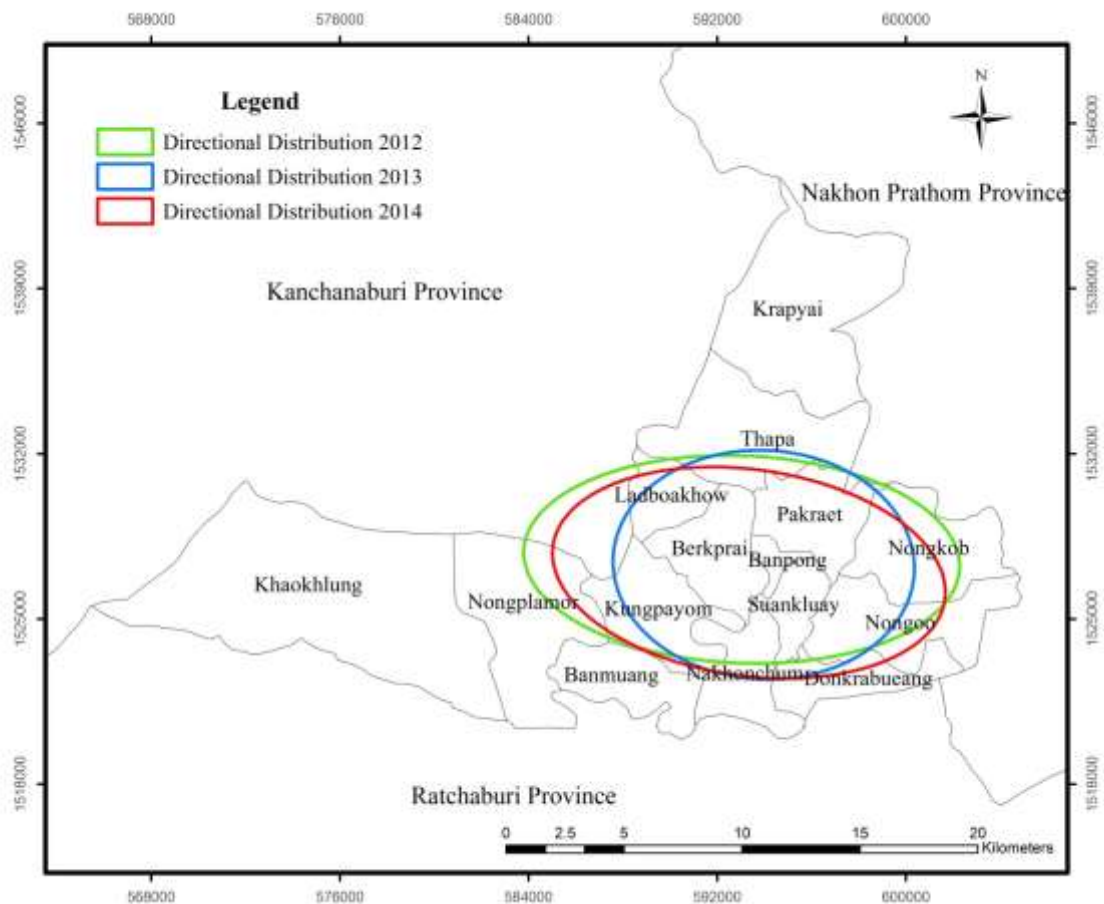


Figure 4 Directional Distribution of burglary incidence from 2012 to 2014.

#### **4. CONCLUSION**

Burglary crime pattern was investigated. It was found that in 3-year period of the study there are similar burglary patterns in all areas of Banpong district. This means that burglary has spread all over Banpong district. The study demonstrates sub-districts containing high burglary rate in 2012 including Thapa and Banpong, respectively. Between 2013 and 2014, it was discovered that high burglary incidence was occurred at one sub-district only including Nongoo in 2013 and Banpong in 2014, respectively. There are some similarities of distribution pattern and trend of burglary incidence over three focused years. Burglary is likely occurred in the eastern part of Banpong district and spread through roughly Banpong area. The reason is that Banpong is centralized in several aspects such as social, economic, commercial and infrastructure factors. These significant factors increase immigrants of Banpong and nearby areas. Such phenomenon creates many problems and negative impacts such as social imbalance, social conflicts and high job competition. Above all, this contributes to high crime rates. The results of the study would benefit governmental sectors in terms of planning, monitoring and surveillance.

Nevertheless, the data acquisition of crime cases is limited to this study. Official recorded burglary incidences are maintained as confidential matters. Therefore it is difficult to access and reveal all information regarding burglary incidence in Ratchaburi province. However, Bangpong district was excluded. Another challenge is that those data are not spatially geo-referenced which make it difficult to identify actual crime locations or burglary scenes. With this regards, the identification of burglary spots can be referred only through spatial correlation with village scale.

This study suggests that the correlation between burglary incidence and other physical features/factors such as land use, landmarks, and population density would enhance the explanation of the areas with high burglary rate so as to achieve in preventing and reducing crime occurrence.

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