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APPLICATION OF KERNEL DENSITY ESTIMATION TO IDENTIFY MOTORCYCLE THEFT HOT SPOTS IN KUCHING, SARAWAK

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Abstract

Motorcycle theft is the most frequently reported cases worldwide, including in Malaysia. This study aims to identify the hot spot areas for motorcycle theft in Kuching. The spatial data include police station sector boundary, road data and latitude and longitude data while attribute data consists of motorcycle theft by year, address of the incident and time. Kernel Density Estimation (KDE) helps to find the hot spot areas of motorcycle theft. Motorcycle theft in Kuching has been reported as more frequent during the day at 54.8% and at 45% during the night from the year 2015 to 2017. Hot spot locations change by year and time. The study found that most of the hot spot areas of motorcycle theft were detected within the Sentral boundary. This indicates that the city centre is an area with a high density of motorcycle theft. This study can help authorities to improve the prevention measures for motorcycle theft while the findings can help in preventing motorcycle theft by police sector boundary.

***Keywords**:* Kernel Density, Motorcycle Theft, Hot Spots, Kuching

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INTRODUCTION

Vehicle Theft Reduction Council of Malaysia Berhad (VTREC) (2021) reported that a vehicle is stolen every one hour 15 minutes in Malaysia (Bernama, 2021). According to Road Transport Department of Malaysia (2020), the total number of registered motorcycles in Malaysia in 2015 was 12,094790 or 45.9%, which was highest in Malaysia compared to the ownership of cars at 45.1%. This growth was due to motorcycle being cheaper than car, and takes up less space for parking. National Insurance Crime Bureau (2020) showed that the top 10 states in the world for motorcycle thefts in 2018 were California, Florida, Texas, New York, South Carolina, North Carolina, Indiana, Missouri, Georgia and Colorado. Besides that, theft of motorcycles is most commonly reported in the Philippines (Godoy, 2020) and it is also contributing a major form of property crime in Nigeria (Ogundipe & Ojedokun, 2017). In Malaysia, government preventions of motorcycle theft are being carried out through better lighting hot spot parking areas, promotion of use of anti-theft U-locks, and using decoys (Hamidi, 2015). Figure 1 shows the trend of property crime in Malaysia by types from 2012-2016. It clearly shows that motorcycle theft cases are most frequently reported in Malaysia.

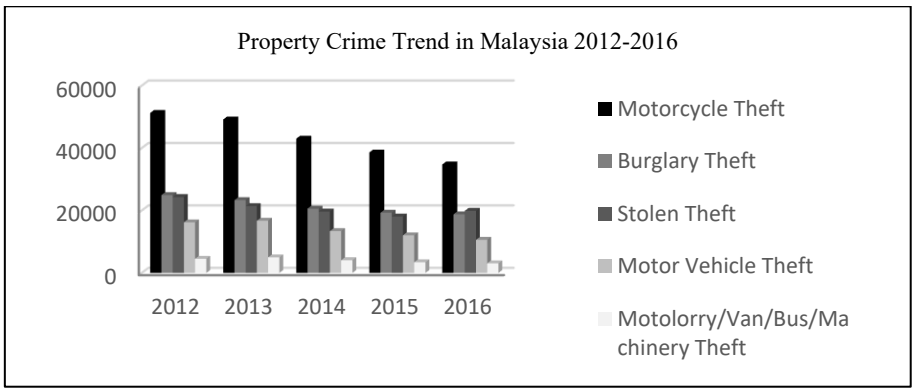


Figure 1: Property Crime Trend in Malaysia 2012-2016
Source: PDRM, (2018)

Statistics 2012-2016 showed that motorcycle theft cases in Malaysia occurred at 42%, followed by burglary cases at 20.7%, while theft cases occurred at 20%, car theft cases 13.3% and the lowest was motorcycle/van/bus/heavy machinery theft cases with 3.8%. Even though the rate of motorcycle theft continues to decrease annually, the total case of motorcycle theft is still alarming high among the category of property crime. The frequent occurrence of motorcycle theft has become a major concern in Malaysia.

LITERATURE REVIEW

Mao et al, (2018) used clustering analysis to identify crime focus areas while spatial autocorrelation technique works to detect areas with high and low clustering. Besides that, other study found the offender pick motorcycle off the ground and load it into a van (Godoy, 2020). This tactic shows that the offender can steal motorcycle when opportunity presents itself. Makrit and Vichuwanich (2021) study spatial analysis of crimes related to motorcycle thefts in Thailand and Cambodia from 2017-2018. Their study found that there was a high density of motorcycle theft cases in the area with high population. Ogundipe & Ojedokun, (2017) found that the thieves steal motorcycle anytime when opportunity arises. This was supported by Ikoh (2011) who suggested that offender always seeks the opportunity to commit crime especially in the areas with low surveillance and security. Jubit et al., (2020a) conducted a study using global Moran's I to identify spatial patterns of property crime in Kuching, Sarawak. The same group of researchers also conducted a study analyzing the property crime hot spots by spatial temporal in Kuching, Sarawak using Getis Ord Gi* (2020b). In Malaysia very few studies focus on the hot spot of motorcycle theft in space and time.

METHODOLOGY

The study area is located in Kuching Sarawak using the database from the Criminal Investigation Division of IPD Kuching (2018). From 2015 to 2017 statistics showed that motorcycle theft cases are the most frequently reported cases compared to other types of property crime in Kuching which is 44%. Thus, the main contributor to property crime in the study area is motorcycle theft. As shown in Figure 2, the police stations for this study consists of 57 sector boundaries. The number of sector boundaries is determined by the PDRM Kuching to increase the effectiveness of patrols and crime prevention. The purpose of using the sector boundary as the unit of analysis in this study is to increase the effectiveness in the prevention of property crime hot spots. This is because the use of smaller units of analysis is more effective as it makes it easier for police to focus on crime prevention involving small areas as opposed to large areas (Braga & Hureau, 2012).

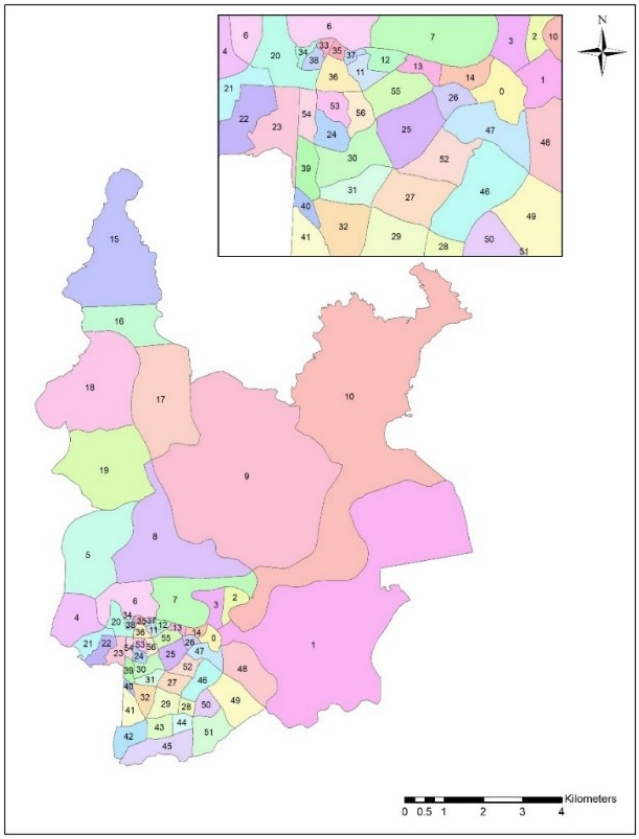


Figure 2: Study Area

ID	Police Station Sectors	1D	Police Station Sectors	ID	Police Station Sectors	1D	Police Station Sectors
0	Bintawa Sector 1	15	Santubong Sector 1	30	Sekama Sector 7	45	Sg Maong Sector 7
1	Bintawa Sector 2	16	Santubong Sector 2	31	Sekama Sector 8	46	Tabuan Jaya Sector 1
2	Bintawa Sector 3	17	Santubong Sector 3	32	Sekama Sector 9	47	Tabuan Jaya Sector 2
3	Bintawa Sector 4	18	Santubong Sector 4	33	Sentral Sector 1	48	Tabuan Jaya Sector 3
4	Gita Sector 1	19	Santubong Sector 5	34	Sentral Sector 10	49	Tabuan Jaya Sector 4
5	Gita Sector 2	20	Satok Sector 1	35	Sentral Sector 2	50	Tabuan Jaya Sector 5
6	Gita Sektor 3	21	Satok Sector 2	36	Sentral Sector 3	51	Tabuan Jaya Sector 6
7	Gita Sector 4	22	Satok Sector 3	37	Sentral Sector 8	52	Tabuan Jaya Sector 7
8	Gita Sector 5	23	Satok Sector 4	38	Sentral Sector 9	53	Sentral Sector 4
9	Gita Sector 6	24	Sentral Sector 6	39	Sg Maong Sector 1	54	Sentral Sector 7
10	Gita Sector 7	25	Sekama Sector 2	40	Sg Maong Sector 2	55	Sekama Sector 1
11	Padungan Sector 1	26	Sekama Sector 3	41	Sg Maong Sector 3	56	Sentral Sector 5
12	Padungan Sector 2	27	Sekama Sector 4	42	Sg Maong Sector 4	30	Sekama Sector 7
13	Padungan Sector 3	28	Sekama Sector 5	43	Sg Maong Sector 5	31	Sekama Sector 8
14	Padungan Sector 4	29	Sekama Sector 6	44	Sg Maong Sector 6	32	Sekama Sector 9

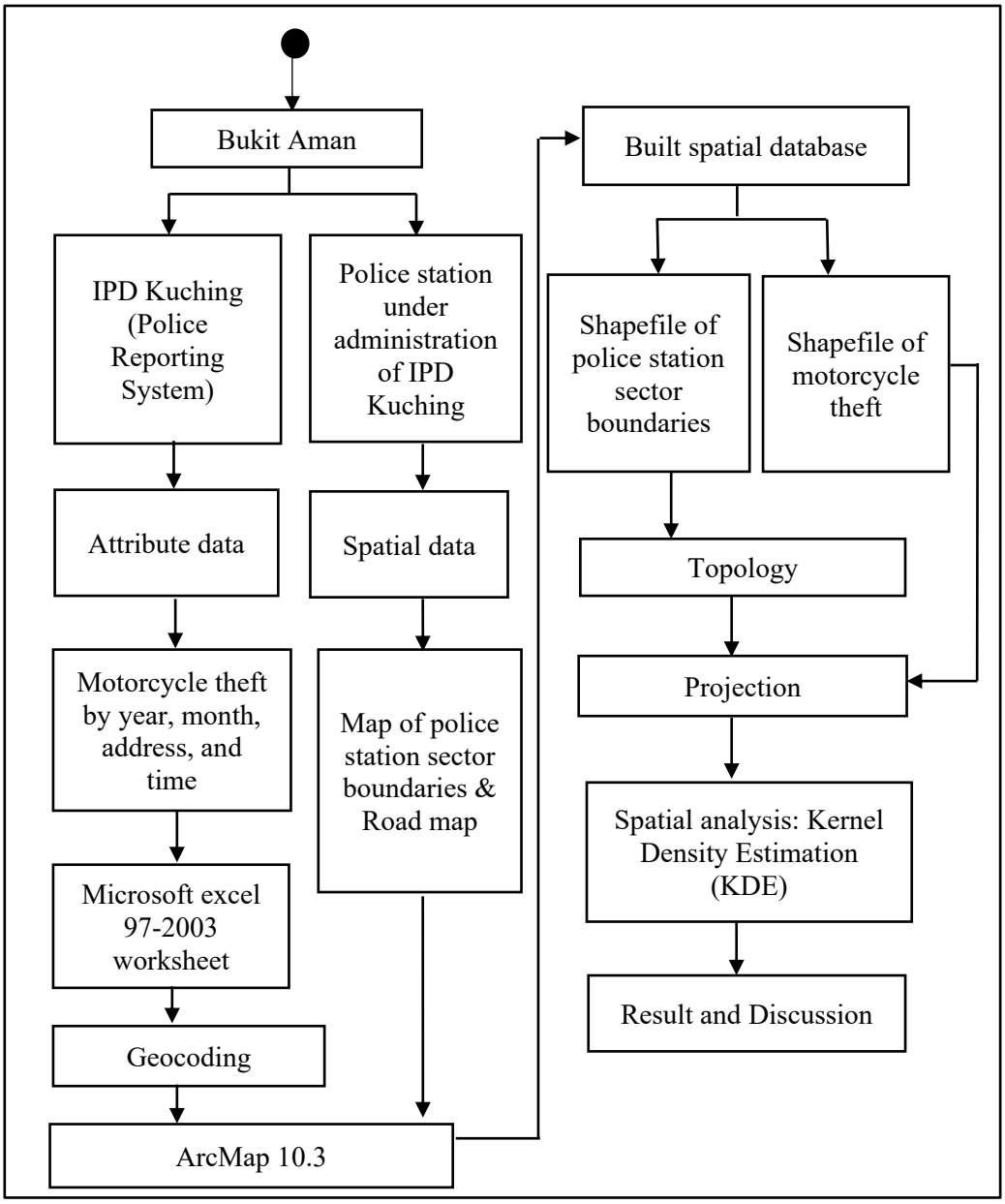


Figure 3: Process of Mapping and Data Analysis

Figure 3 shows the process of mapping and data analysis. Attribute data was taken from the Police Reporting System at IPD Kuching which consist of motorcycle theft by year, month, address of the incident and time (daytime = 7 a.m-6.59 p.m.) and (nighttime = 7 p.m-6.59 a.m.) This data was then compiled in Microsoft Excel 97-2003 worksheet. The geocoding process was carried out to obtain latitude and longitude data. Spatial data was obtained from police stations under the administration of IPD Kuching. This included a map of police station sector boundaries (57) and a road map for digitizing. The next process was to build spatial database. Spatial data was change to shapefile, then transform into a topology to clean up data entry errors and to verify data while attribute data was also converted into shapefile. The spatial data and attribute data then went through the process of projection. The last step was to run the Kernel Density Estimation analysis to get the result. A kernel density shows the hot spot of motorcycle theft across the police station sector boundary by concentration density of point. There are five classificationss of point density, namely lowest risk, low risk, moderate risk, high risk and higher risk. The function of kernel density is to calculates the density of features in a neighbourhood around those features. Kernel density is also use in creating a continuous map of feature density. The feature located close to the point shows greater weighting, while a feature located some distance away receives a negligible weighting (King et al., 2016). Besides that, Sari et al., (2020) found that kernel density using interpolation of points distribution with the grid-based distribution to identify hot spots area. It also estimates the intensity through the calculation of the amount which is detected in a specific area.

RESULTS

HOT SPOT OF MOTORCYCLE THEFT IN KUCHING 2015-2017

Figure 4 (a) shows the result of motorcycle theft 2015 by using the kernel density. Ten police station sectors were identified as hot spots for motorcycle theft cases in 2015, namely sector 1 in the Satok border, sectors 1, 2, 8, 9 and 10 in the Sentral sector border and sectors 1 and 2 in the border of Padungan and Sg. Maong. In 2016, most of the hot spots were detected in the Sentral police station sector boundary, including sectors 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10. Motorcycle theft case hot spots were also identified in sector 1 in the sector boundary of Satok, sector 3 located at Gita boundary, sector 1 located at Sekama sector boundary. The analysis found that sectors 1 and 2 in the Padungan boundary were also classified as hot spots of motorcycle theft in 2016 (Refer Figure 4(b). In 2017 a total of 10 sectors in the Sentral boundary were classified as hot spots of motorcycle theft cases. Sectors 1 and 2 which located at Padungan boundary and sector 1 located at Gita boundary as well as sector 1 located at Satok boundary also detected as hot spots as shown in Figure 4(c).

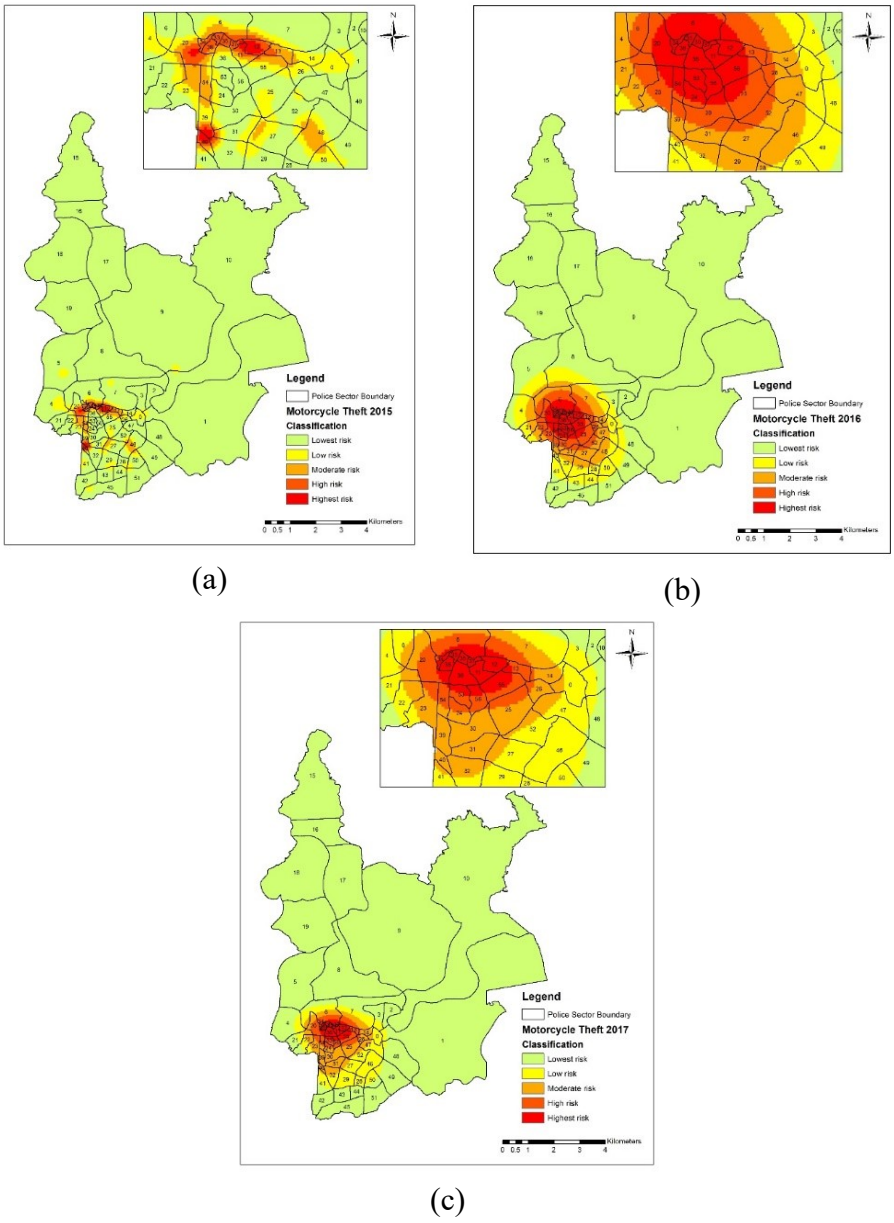


Figure 4: Hot spot of Motorcycle Theft in Kuching, Sarawak for (a) 2015, (b) 2016 and (c) 2017

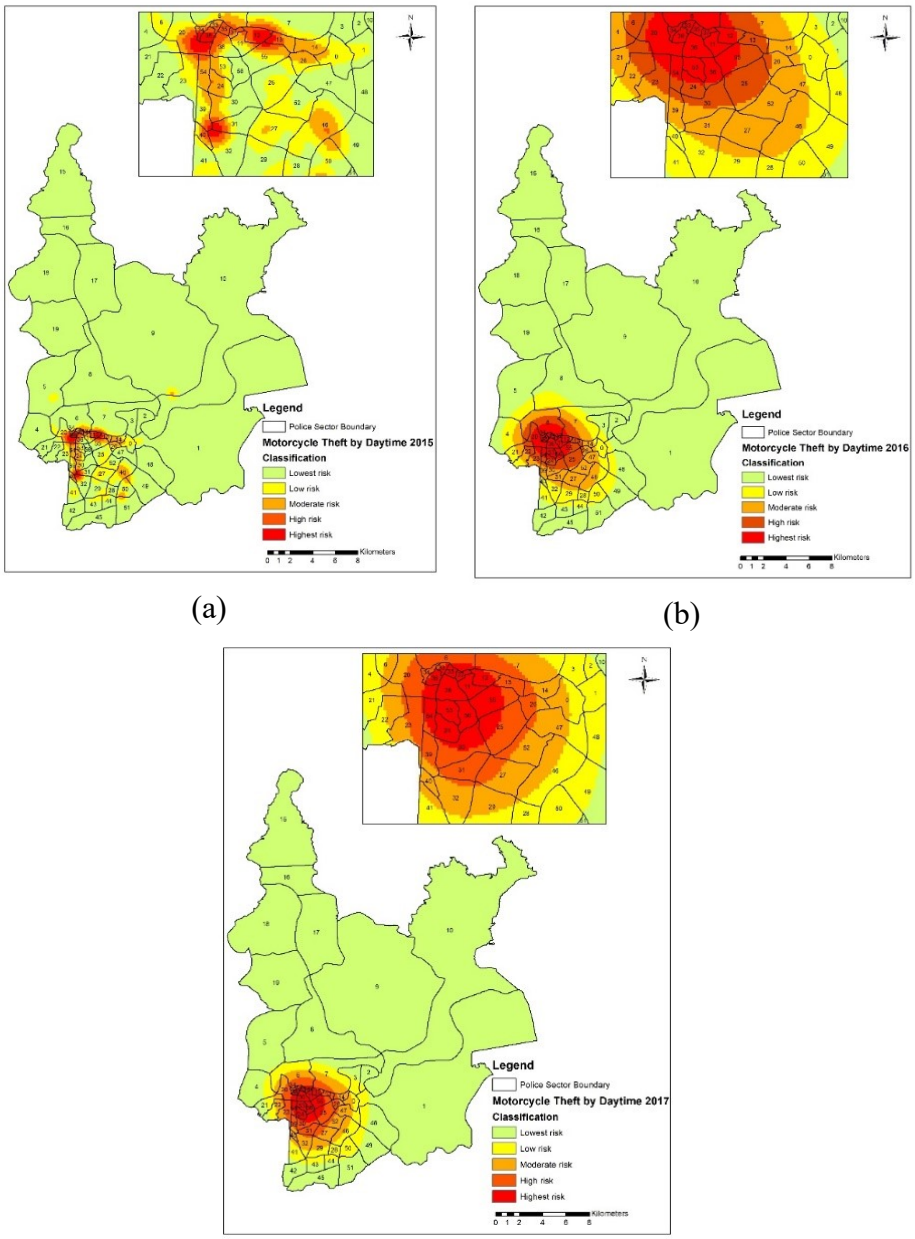
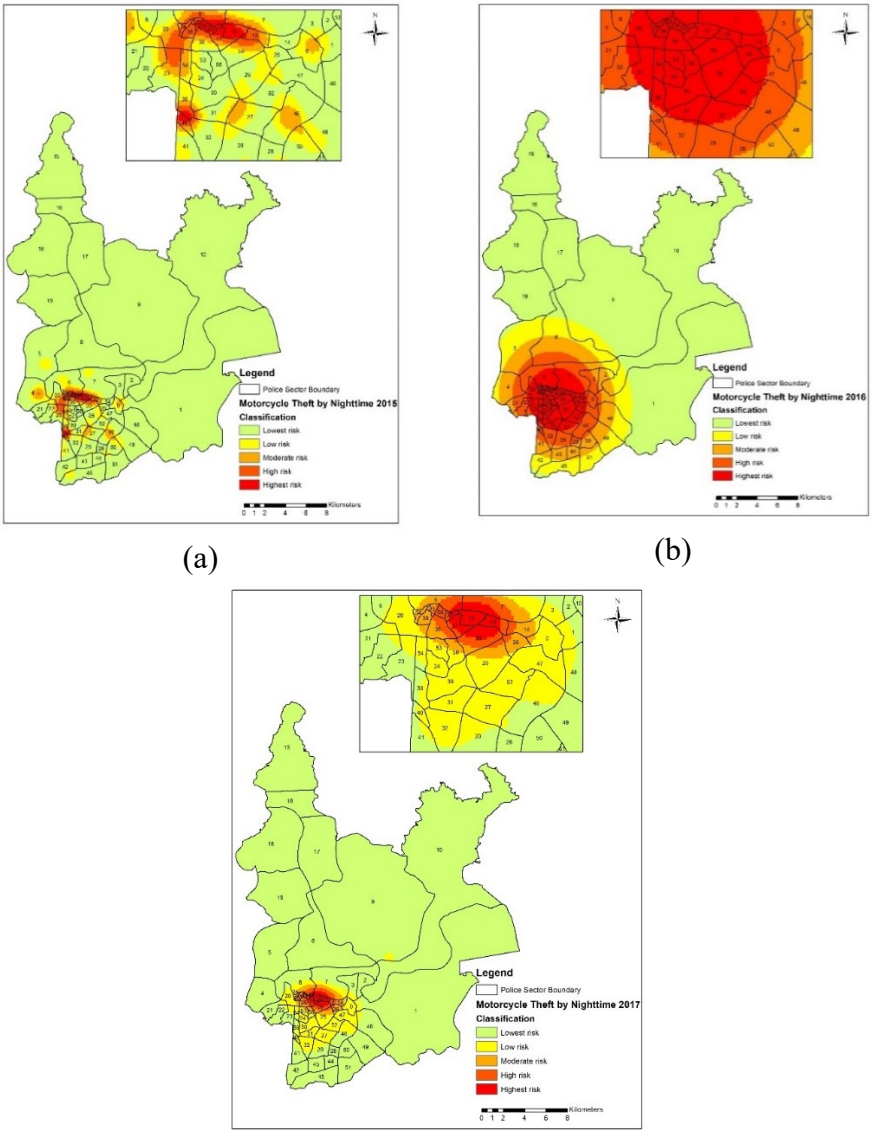


Figure 5: Hot spot of Motorcycle Theft by Daytime in Kuching, Sarawak for (a) 2015, (b) 2016 and (c) 2017



(a) (b)

(c)

Figure 6: Hot spot of Motorcycle Theft by Nighttime in Kuching, Sarawak for (a) 2015, (b) 2016 and (c) 2017

Figure 5 shows hot spots of motorcycle theft by daytime in Kuching, Sarawak from 2015-2017. In 2015, there were 7 areas detected to have the highest clustering of motorcycle theft (Refer Figure 5a). In 2016, there were 13 areas reported to register the highest clustering rate and were categorized as the most

at risk of motorcycle theft cases in Kuching as shown in Figure 5(b). In 2017, the areas that were classified as motorcycle theft hot spots increased to 14 areas. However, only 3 areas were involved, namely the Sentral, Padungan and Sekama boundaries as shown in Figure 5(c). Figure 6 shows the hot spots of motorcycle theft at nighttime in Kuching, Sarawak for the year 2015-2017. This study found that 5 sectors were classified as hot spots of motorcycle theft at nighttime in 2015 as shown in Figure 6(a). In 2016 the number of hot spot areas for motorcycle theft have increased [Refer Figure 6(b)]. In 2017, the number of hot spots was detected at 5 areas [Refer Figure 6(c)].

DISCUSSION

The visualization classified from lowest risk into highest risk proves to be useful in visually identifying hot spots of motorcycle theft in Kuching, Sarawak. From this study, kernel density helps to identify the concentrated point. The findings here show that hot spots of motorcycle theft mostly occurred in Sentral boundaries sector. This is because the Sentral area is an area that is often the focus of the public. There were more people concentrated in Sentral because this area has a shopping complex, waterfront, eateries, hotels and many motorcycle parking facilities. The frequency of motorcycle theft in Sentral boundaries indicates that motorcycle parking is unsafe and the environment has a high opportunity of crime. Crime occurs influenced by space and the present of victims at daytime and night-time. The results indicate that motorcycle theft is mostly around CBD, however the lowest risk was detected away from the city centres. In Kuching, motorcycle theft mostly occurred during the daytime from 7 am to 6.59 pm which is 54.8% while at night between 7 pm to 6.59 am and the number of cases reported was 45% in the period 2015-2017. This shows that motorcycle theft in Kuching has something to do with routine human activities. During the daytime most motorcycle owners go out of the house, go to work, shop and do various activities that contribute to the high presence of motorcycles in the downtown area. The lack of surveillance and the presence of criminals has created a high chance of motorcycle theft.

CONCLUSION

Areas with high crime clustering densities cannot be detected without using GIS analysis especially when involving the spatial element such as the boundaries of the police station sector. This is because the PDRM detects hot spots based on the number of motorcycle theft cases that has been reported. The IPD Kuching classified area as hot spot depends on total cases that has been reported which is the police station with highest cases of motorcycle theft will be identified as hot spots, while if the police station were identified with lowest cases will be classified as cold spots areas. However, the identifying of hot spot areas based on the number of cases that has been reported could not detect the motorcycle theft

hot spot by sector boundaries with the highest criminal case clustering density. Thus, Kernel Density Estimation analysis helps to detect areas or sectors of the hall that are classified as hot spots and preventive measures can be done more effectively. This study contributes to policy makers in spatial crime prevention decision making. In addition, this study helps to reveal property crime hot spots and crime prevention areas that should be focused by local authorities such as North Kuching City Hall (DBKU), South Kuching Municipal Council (MPKS) and Padawan Municipal Council (MPP).

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