Article Journal of Asian Geography, 2022, Volume 1 (Issue 1), 25-33.

Geographic Information System for Crime Mapping: A Case Study of Property Crime in Kuching, Sarawak

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Received: 2 Mac 2022; Revised: 15 Mac 2022; Accepted: 25 Mar 2022; Published 21 Sep 2022

Abstract: Residents in Kuching claim to be worried about the increasingly of property crime. In Sarawak property crime was reported more frequent occur and contribute 88% cases compared with violent crime 11.2%. The aim of the study is to identify the spatial pattern of property crime in Kuching, Sarawak. This study using spatial data such as road data, police station boundary and police sector boundary that obtained from police station heads in the form of pictures and street names. Digitization was conducted based on road data to facilitate accurate dividing of police sector boundaries. Non-spatial data including property crime cases (2015-2017), month, time, types and incident address which is taken directly from the Police Reporting System. The crime data in PRS does not contain any coordinate reference system (x, y) and GIS help to locate the coordinate through the address of the incidents. Global Moran's I tool help to identify the overall pattern and trend of property crime in Kuching, Sarawak. This study has shown that the spatial pattern of property crime in Kuching, Sarawak in 2015-2017 was random because of p value greater than 1.0 and Moran's Index approaching zero. However, the result of stolen cases showed a positive spatial autocorrelation p-value of 0.063805 ($p<0.10$) indicating a case was clustered with 90% of confidence level in 2015. The result of stolen cases showed p-value 0.000371 ($p<0.01$) which indicate cluster at 90% of confindece level. The stolen cases in Kuching showed a strong positive spatial autocorrelation in 2017 because z-score of 2.830712 greater than 2.58 with the p-value of 0.004644 ($p<0.01$). Thus, the stolen cases do not occur at random in 2015-2017. This study can help police and authorities in making decision for preventing property crime.

Keyword: Geographic Information System; Crime Mapping; Property Crime; Kuching; Global Moran's I.

1.0 Introduction

Space is an interconnected element of crime in the city (Ceccato, 2008). Crime can occur in certain locations. Thus the aspect of space is often emphasized in criminal studies (Jubit et al., 2020a; Jubit et al., 2019 Nordin et al., 2020; Zakaria & Abdul Rahman, 2016; Carter et al., 2020; Ibrahim et al., 2016 ; LaRue 2013). Space autocorrelation was introduced by Sir Francis Galton in 1850 who was also a cousin of Charles Darwin (Getis, 2008). The idea of space autocorrelation exists because the need to compare maps and awareness of a phenomenon does not occur randomly in space but rather clustered or centralized. Hubert et.al, (1981) defines space autocorrelation as;"Given a set S containing n geographical units, spatial autocorrelation refers to the relationship between some variable observed in each of the n localities and a measure of geographical proximity defined for all n (n-1) pairs chosen from n".

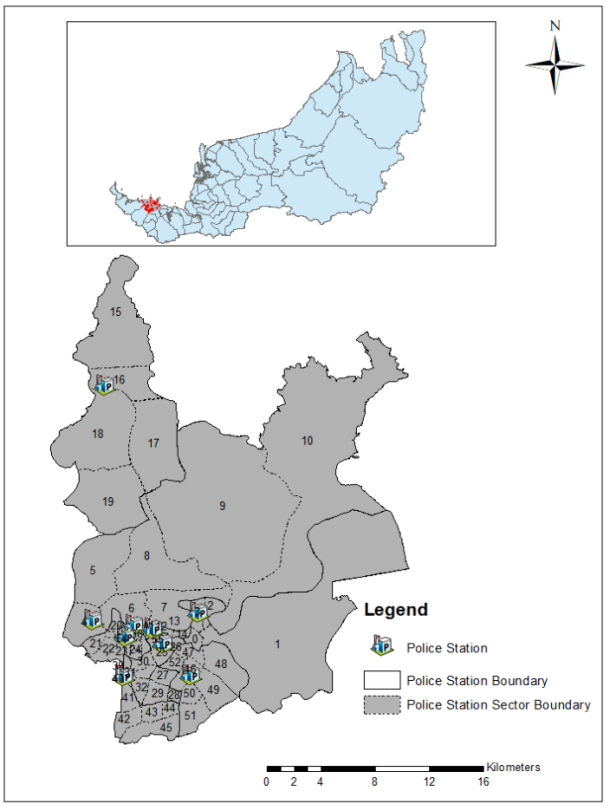
The occurrence of crime in space context can be seen in the growth of urban population which leads to an increase of crime cases in urban areas. There were 60% to 70% of the total urban population that have become victims of crime, especially in developing countries due to the high growth of population. High population density and complex infrastructure, the existence of slums, illegal immigrants and drug addiction have made urban areas potentially become a hot spot of crime such as extortion and snatch theft cases (UN-HABITAT, 2016). In addition, physical environmental factors also contribute to the existence of property crime. The spatial design of physical features has an impact on the pattern of crime, target, surveillance and location. Criminals are more attracted to areas with high crime rates. The types of housing characterized by road design influence the occurrence of crime (John et.al, 2018). For example, physical surveillance and commercial space design influence the occurrence of property crime in commercial areas (Byun and Ha, 2016). Nordin and Masron, (2016) have identified drug hot spot in the Northeast District in Penang, Malaysia by using Getis Ord Gi*. In 2013, 7 sectors were detected as hot spot while in 2014 there are 3 sectors were classified as hot spots. Jubit et al., (2021) conducted a study motorcycle theft hot spots in Kuching, Sarawak by using Kernel Density Estimation. 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

The same goes for the location of the police station which affects the numbers of crime rate. (There is no information about number of cases from literature review) Areas that are closer to the police station have a declining crime rate. Physical environmental factors such as various services and land use influence criminal behavior (Ahmed and Salihu, 2013). This shows that space as a location plays an important role in understanding the phenomenon of crime. Advances in new technologies for data storage and analysis such as GIS have led to the creation of systems that visualize and analyze crimes that have been processed through encoding in large numbers (Ceccato, 2008). Thus, crime analysis using GIS allows researchers to study crime in spatial context in a more dynamic way. This paper aims to analyze the spatial pattern of property crime in Kuching, Sarawak. Property crime was selected as the focus of this study due to the more frequent cases of property crime in Sarawak which is reported at 88.8% while violent crime 11.2% in the period of 2004-2016 and Kuching is one of the major cities in Sarawak which recorded the highest property crime rate

2.0 Study Area

Kuching district has an area of 1, 862.8 sq km (Sarawak Department of Statistics, 2015). Kuching is located in the southwest of Sarawak with latitude 1.6019N and longitude 110.3244E (Soo et al., 2016). In addition, Kuching is the fastest growing area in Sarawak and attracts more people (Lai, et al., 2008). Kuching also has the highest population percentage in Sarawak with a total population of 617,887 people in 2010. Kuching is the capital of Sarawak and was declared a city in August 1988. The city is the main focus of the population in Sarawak due to rapid development and economic opportunities. Kuching is the 7th Metropolitan city among the 14 states in Malaysia while at the Sarawak level, Kuching is the first-ranked Metropolitan city followed by Miri and Sibu (Sarawak Department of Statistics, 2015). Kuching also experienced strong economic growth, increased per capita income and high industrial productivity which led to the rapid growth of municipalities in Kuching compared to other districts in Sarawak (World Bank Group, 2018). Kuching district has nine police stations with a total of 57 police station sectors administered under the Kuching District Police Headquarters and this area has been the focus of the study namely (1) Padungan, (2) Bintawa, (3) Sekama, (4) Tabuan Jaya, (5) Sungai Maong, (6) Gita, (7) Santubong, (8) Central, and (9) Satok as shown in Figure 1.

E-ISSN: 2948-5231



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 1: Study Area

3.0 Data and Methodology

Figure 2 shows the process of collecting data and spatial analysis. The first step in data collection process was to apply the approval from Crime Investigation Department of Bukit Aman to get the data from Kuching District Police Headquarters. After receiving the approval the next step was collecting data. There were two types of data namely spatial data and non spatial data. The spatial data was taken directly from police stations under the administration of Kuching District Police Headquarters. The spatial data consists of police station boundaries (9 police stations), police station sector boundaries (57 sectors) and road data. The next step was the process of building a spatial database using ArcMap 10.3. While non spatial data include property crime (2015-2017) by police stations of Kuching, Sarawak, types of property crime, address of incidents and date of incidents. All this non spatial data were taken directly from Police Reporting System of Kuching District Police Headquarters and were sorted out using Microsoft Excel 1997. The information was later transfer to data sheet before it is uploaded into Geocoded to track the location of an address by using geographical coordinates. Geocoding enables researchers to track the location of property crime cases to be displayed in the forms of point on the map. The projection was set up to ensure the coordinate system of property crime cases with the police station sector boundaries were the same

E-ISSN: 2948-5231