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Research paper

Street Pattern Identification for Crime Prevention through Environmental Design

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Abstract

Malaysia is one of the countries that is facing rapid urbanization. The crime rates are getting worse by the day and has become one of the threats faced by the community. The number of cases and incidents of snatch theft in Malaysia are fluctuating from the year of 2010 until the year 2015. Four major cities in Malaysia with high rates of snatch theft include Selangor, Kuala Lumpur, Penang and Johor with 5,553 cases, 4,687 cases, 1,953 cases, and 298 cases respectively. Hence, crime prevention and common crimes of opportunities such as snatch incidents should be addressed in urban planning. This paper focuses on street pattern identification for crime prevention through environmental design. In this study, the street pattern that are vulnerable to incidences of snatch theft have been identified using Geographic Information System (GIS). The result confirmed that the fragmented parallel street is prone to crime as stated in the theory of street pattern. Previous studies by other scholars found that the street with a high turning point is relatively prone to crime. This is confirmed in this study that a high turning point is correlative with the fragmented parallel street pattern.

Keywords: *CPTED, Crime, Hotspot, Snatch theft, Street Pattern.*

1. Introduction

The number of snatch theft cases are on the rise and are at a precarious level since these cases lead to fatalities [1]. This particular type of crime creates a huge impact on society whereby it creates at atmosphere of panic, anxiety and fear. There are snatch theft incidents in Malaysia that had been announced in the local television news and also some video recordings by witnesses that that have gone viral on the internet. These incidents developed a sense of fear among the urban citizens especially people who are walking to and fro a particular place [2]. The crime presence within an urban area is adversely affecting the quality of life of the society and it is deteriorating day by day. This statement is also supported by [3] where it is important to develop an appropriate design of the built environment since good environment design has an essential impact on the quality of life of the people. Until today, Malaysia is still facing difficulties related to snatch theft cases. Malaysia is one of the countries that is facing rapid urbanization. The crime rates are getting worse by the day and has become one of the threats faced by the citizens. The number of cases and incidents of snatch theft in Malaysia has fluctuated throughout 6 years from the year 2010 until the year 2015. Even though the figures in the statistical data of the snatch theft cases are fluctuating every year, the fear among the public are still increasing every year as stated by Tan Sri Lam Thye who is the Malaysia Crime Prevention Foundation (MCPF) vice chairman [4]. At present, cities are becoming more appealing to the people from the rural areas due to its vast economic and employment opportunities. Hence, the crime prevention and common crimes of opportunities such as snatch theft incidents should be addressed in urban planning. The government is greatly aware of this issue and is putting great effort in reducing the crime rates through the National Key Result Areas (NKRA) which has been established in the Government Transformation Program (GTP) in the year of 2004 [31]. The Home Affairs Ministry and the Royal Malaysian Police (RMP) believed that Crime Prevention through Environmental Design (CPTED) can reduce crime rates. CPTED in Malaysia is known as the Safe City Program that serves as a tool and guideline to reduce crime thus improving the citizens' quality of life. Therefore, it is essential especially for the architects, planners and other experts in the related fields involved to understand the importance of addressing the issues [3].

Crime that are likely to be undistributed over space and highly concentrated in some or certain areas and consists of fear concentration, no matter whether criminal incidents have occurred or not are called 'hot spots' [5]. 'Hot spots' of crime arise at a variety of scales from the community to the block to the specific situations [6]. After a crime mapping process is done based on the police recorded reports from the victims, hotspot areas are obtained. The maps of the hotspots of crime that are accurately identified and clearly visualized will definitely give an advantage to the police organization by guiding visualization of threat, allocation of police resource and prediction of the crime activities in the area [7]. With the latest developments in crime mapping, one can find various sizes of hot spots, from a hot spot place to hot spot regions. The most important thing is the factor that leads to the creation of the hot spots places, hot spots streets, hot spots neighborhoods, or hot spots cities. In addition, the actions of a person who is required to deal with the hot spots place will be

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different from the actions needed to address a hot spots street, hot spots neighborhood, or hot spots city. Therefore, to understand the theory basis for the hot spots of crime is crucial. Hot spots of crime map that are accurately identified and clearly visualized will definitely provide an edge to the police organization by guiding visualization of threat, allocation of police resource and prediction of crime [7]. Techniques for detecting crime hotspots have been developed for several years, although there are no means at the stage where they are both definitive and applicable [8].

Generally, snatch theft is a criminal act of stealing property of other people by engaging rob-and-run tactics [1]. Most of the incidents are normally committed by the offenders who are riding on a motorcycle wearing a full faced helmet which makes it easier for them to escape and safer because they will remain unrecognized. Snatch thieves will either work alone or with a pillion rider, who is the one who usually snatches the targeted items from pedestrians or other people either on motorcycles or cars, while the motorcyclist rider rides away after obtaining their desired things. But there is also another method used by the snatch thieves which is called the smash-and-snatch tactic [1]. This tactic involves both the motorcyclist and a pillion rider where the pillion rider will smash one of the car windows in order to snatch away the handbags or laptops that is located at any of the passenger seats in the car. This tactic occurs in a second without any verbal exchange between the offenders and the victims before the robbery [9]. The most common purse snatching incidents is that there will be two thieves riding a motorcycle, speed up towards a victim from behind where the passenger on the back snatches valuable items such as purse, handbag, or cellular phone. Thieves have also conducted snatch thefts while leaning out of the passenger side of moving vehicles [10].

Street and crime has a relation that existed for a very long time. Residents living in highly accessible street layouts are statistically more likely to be fearful of crime and experience low social unity and it was also found that crimes often take place in these highly accessible places [11] [12]. The changes in shape and connectivity of the street patterns are being emphasized in [13] shown below which is going from fully-connected networks to increasingly more dendritic networks. Southworth stated the evolution started from 1900s to 1980s. He found the street pattern from higher to lower access of the streets. Actually it is not just about the changes in connectivity and shape of the streets but also the density which has an increasingly less dense network over the last half of the late 20th century. These diverse changes are usually diverse by many observers of this evolution in the street network [14].

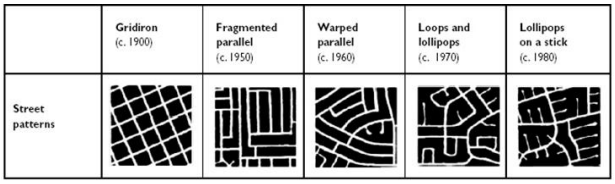


Fig. 1: Evolution of street patterns from 1900s to 1980s
(Source: Southworth, 1997)

The previous scholars have classified the street patterns into five typical categories as shown in Fig. 1. The patterns were gridiron, fragmented parallel, warped Parallel, loops and Lollipops and lollipops on a stick [15]. The gridiron street layout is a traditional pattern which exists in most of the early urban planning for example in European countries. The advantage of this pattern is that it helps a compact settlement to use the space efficiently because the gridiron pattern mainly consists of linear roads. The gridiron street pattern reappear in some settlements, which are easily linked to each other. This kind of street has favorable features such as being easy to survey and have very clear directions which makes it easier to make shortcuts from one place to another. The gridiron pattern is very popular among most of the road engineers and the planners obviously due to its simplicity [16]. However nowadays, most of the cities have taken the street hierarchy, curvilinear design, and disconnected networks into consideration [17]. From the snatch incident aspects, the gridiron pattern provide the most accessibility as compared to the other four street patterns which can provide a number of easy entries and countless number of escape routes for the offenders. Since the snatch theft offenders are likely to ride a motorcycle, it will be very easy for them to escape by doing different turnings at every single road segments within the gridiron layout. [18] observed that the streets with the high level of activities and presence of people, the crime activities are lower [19]. The design of these roads as observed by Jacobs are more conventional and in grid layout, where people who pass by acts as a casual surveillance [19].

The second type of street pattern is the fragmented parallel pattern which has the most street segments of T intersections and L-shaped corners. Moreover, the number of access points for this pattern, the preferred routes through a neighborhood and the interconnection of street are reduced. Although, this pattern has almost the same street length as the gridiron, it has limitations in the number of traffic flow [20]. The next street pattern is the warped parallel pattern. This pattern has similarities with the fragmented parallel pattern in the shape of a space. Its characteristics consist of long and narrow blocks, hardly consists of any preferred route, crossroad intersections and interconnection are limited, but it has a curvilinear rather than straight road or street. Curved road usually creates the impression of rural area and the visual length is shortened and the topography is used to generate this pattern [16]. The orientation of the users in the block is confused by the curvilinear street [20]. As a whole, compared with the fragmented parallel, it is not an auto-friendly block with the warped parallel pattern [16]. The fourth type of the street pattern is the loops and lollipops pattern. The street design is an evolution from the warped parallel to loops and lollipops pattern since 1970. This street pattern consists of a number of loops and cul-de-sacs within the layout which multiplies the direction of the street. The limitation of the connectivity gives a sense of privacy and calmness [16]. The limited accessibility is an even more severe problem than the other non-loops patterns. Thus, both vehicles and pedestrians will be less interested to cross or use the paths through communities with this kind of street pattern [20]. Last but not least, the final pattern is the lollipops on a stick street pattern. This pattern is also named or known as cul-de-sacs or streets with dead-ends. It has the least linkages, preferred routes and accessibilities [20]. When other forms of street pattern such as cul-de-sacs and loops were introduced, residential layouts appear to have lesser continuous, linear and through streets [19]. Therefore, an appropriate tool to analyze the context of a more general built environment is provided. It has a certain significance in the criminal case in which the target is an element of the built environment, and therefore is at a fixed point on the network such as burglary, that will be considered here.

Street networks dominate the movement patterns, awareness space and criminals target choices, especially those who are using vehicles or street-level public transportation [21]. This indirectly shows that the formation of the built environment affects the individual activities [22]. The relationship between the urban form and crime always relate with the linkage of the street pattern. The street linkage is defined as a path moving from any two or more locations which is the basic element for pedestrians and vehicular movement in an urban area. We assumed that street connections would contribute to snatching occurrences because most snatches occurred on streets [23]. There are two slight different views on the relationship between street layouts and fear of crime that was highlighted in the existing literature over-

view [11]. The street sidewalk usage which brings in more strangers is a basic feature of a safe city [18] while the other one is the defensible space concept suggested that the higher perceived use and density of people on city streets are associated with greater levels of fear [24]. Newman also insisted in restricting access, minimizing interconnectedness and a clear demarcation between public and private spaces. It should be noted however that the context in which both of Jacobs and Newman's studies operate may be the influencing factor. [18] drew attention to the urban design and narrowed the investigation area of crime-space studies. Her study is more concerned with macro-scale planning such as commercial and business settings, while Newman's work focused on microscale settings such as public housing and residential settings [18].

Crime Prevention through Environmental Design or CPTED is a crime prevention philosophy based on the theory that the proper design and effective use of the built environment can lead to a reduction in the fear of crime as well as an improvement in the quality of life [25]. CPTED principles consist of four elements. It is subject to continuing refinement and evaluation and builds upon four key strategies of territoriality, natural surveillance, maintenance and target hardening, and access control [26]. The first principle is territoriality, which is assumed as people protecting their own legitimate space that creates the 'sense of ownership', hence reducing the opportunities for offences to be committed by discouraging illegitimate users [26] [27] the second one is surveillance, a crucial dimension since criminals generally do not wish to be observed and seen [26]. It is based on physical design which indirectly or unintentionally provides the capacity to promote informal or natural surveillance opportunities for residents and it is also considered to be part of capable guardianship [27] the third principles is maintenance and target hardening. This principle promotes a positive image and routinely maintains the built environment to ensure that the physical environment continues to function effectively and transmits positive signals to all users [27] and last but not least, the fourth one that is access control which is a concept to encourage the approved users whilst discouraging the offenders who may seek to abuse the space [26]. It is meant to reduce the crime opportunities by denying access to potential targets and creating a heightened perception of risk in offenders [26] [27]. CPTED works by decreasing a criminal's ability to commit crime and increasing the chances that the crime will be seen by legitimate citizens. CPTED goes beyond traditional security methods by naturally integrating security measures into the community. Every CPTED application aim is to boost the quality of life, fear of crime, and decline crimes.

In the context of this field, the study done by [28] used space syntax to examine the burglary cases and the relationship of the residential area with the physical environment. The indication of the characteristics in the urban layouts that influenced the unequal distribution of burglary was also done by [19]. With regards to this study, it is quite challenging to find previous studies regarding the relationship between street pattern and snatch theft incidents with CPTED. Therefore, this paper presents street pattern identification for Crime Prevention through Environmental Design. In this study, the hotspot area of snatch theft with street pattern and relationship with the physical environment will be identified.

2. Methodology

This research is a qualitative approach. The research process for this research has been shown and explained in Figure 2. Research process as shown in Figure 2 explained that snatch theft crime data obtained from Polis Diraja Malaysia (PDRM) from 2010 till 2015. From the four main cities in Malaysia which are Selangor, Kuala Lumpur, Penang and Johor, it was found that Selangor has the highest number of snatch theft cases. In Selangor, there are 15 districts and the district of Ampang Jaya is the district with the most number of snatch theft activities for 6 years (2010 to 2015) – refer Table 1.

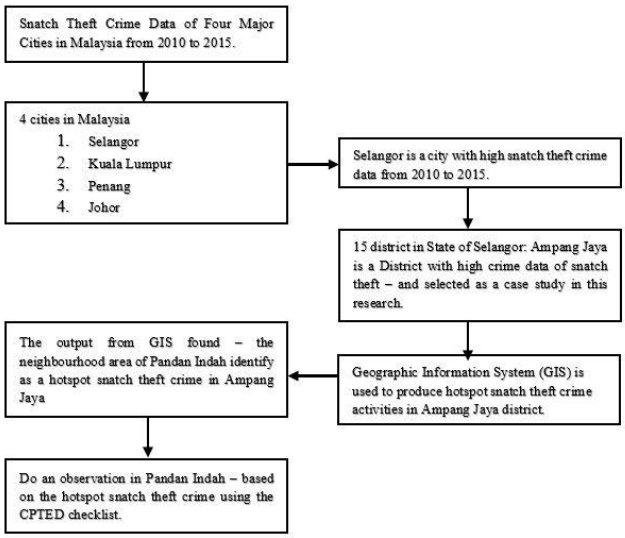


Fig. 2: Research Process

Table 1: Snatch Theft Crime Data in 15 districts in Selangor from 2010 to 2015

No	District	2010	2011	2012	2013	2014	2015	Total by District
1	**Ampang Jaya**	**429**	**260**	**321**	**322**	**257**	**220**	**1809**
2	Gombak	67	8	5	5	1	3	89
3	Ulu Selangor	6	1	2	5	3	10	27
4	Kajang	16	1	79	127	150	128	501
5	Klang Selatan	114	90	13	82	31	21	369
6	Klang Utara	14	31	13	31	17	14	120
7	Kuala Langat	25	12	4	6	9	8	64
8	Kuala Selangor	23	14	2	1	2	4	46

9	Petaling Jaya	135	79	82	183	153	355	987
10	Sabak Bernam	42	19	17	15	21	27	141
11	Sepang	13	7	6	4	11	8	49
12	Serdang	66	82	30	50	22	41	291
13	Shah Alam	102	43	7	6	3	2	163
14	Subang Jaya	195	152	127	130	151	70	825
15	Sungai Buloh	-	-	-	18	15	39	72

(Source: PDRM, 2016)

The Geographic Information System (GIS) is used for this study in order to produce hotspot map based on the snatch theft statistical data from PDRM. Snatch theft hotspot map is produced after the police data is inserted into the map of Ampang Jaya by using ArcMap 10.2. The areas in Ampang Jaya is divided according to the existing districts. After the data has been inserted and snatch theft incidents are located, these areas were categorised into five different colour codes which are red, orange, yellow, light green and green in order to identify which area is the hotspot area. Red represents an area with the highest number of snatch theft cases while green with the lowest or no snatch theft cases. Based on the result of hotspot area from GIS, the observation of the area using the CPTED checklist has been done.

3. Result and Discussion

The Image 4(a-f) displays the results of the hotspot map obtained using ArcMap 10.2 from the year of 2010 until 2015 respectively. The dotted lines represent the number of cases which occurred within the particular area according to the statistical data from the Royal Malaysian Police (RMP). These six maps show the pattern of the distribution of the snatch theft incidents in Ampang Jaya district. It can be seen that the snatch theft activities tend to take place on the southwest of Ampang Jaya. Based on the maps in

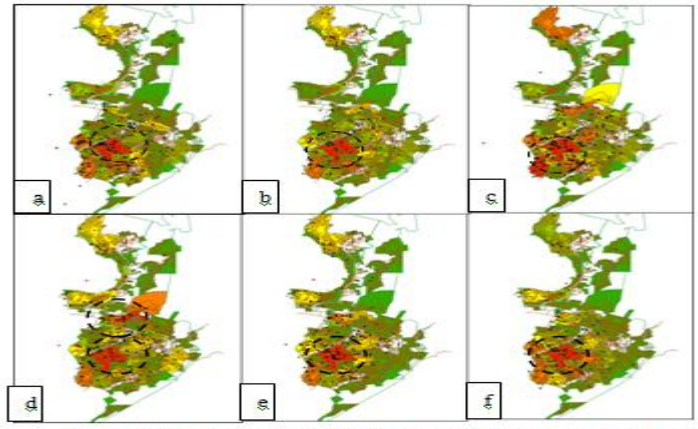


Fig. 3: (a-f) Snatch theft cases in Ampang Jaya from 2010 until 2015

Fig.3(c), Ampang Jaya faced the most number of cases of snatch theft whereby the color changed from the previous year in Fig.3(a-b). However, in Fig.3(d-f), it seems there are certain places that experienced a decline in the number of snatch theft incidents especially in the northern part of Ampang Jaya. From Fig.3(a-f), the hotspot area is shown in red which is located in Pandan Indah, Ampang as shown in Fig.4. Land use development in Pandan Indah involves mix land use comprising commercial, residential, educational, industrial and other facilities. Fig.5 shows hotspot area in Pandan Indah where the dotted line for 6 years is directed at the same area.

Fig.5 above shows the hotspot area which is Taman Pandan Indah. The layout of Taman Pandan Indah is shown in Fig.6 and the street pattern of the residential has been identified. Using the theory of street pattern by [13], it is found that the street pattern in Pandan Indah is the fragmented parallel pattern. This street pattern is more predisposed to criminal activities because most of its street segments are T intersections and L-shaped corners [13]. This is supported by [21] which found that the increasing number of street segments and street turning increased the ability to connect from one place to another which ultimately makes it easier for criminals to escape. This correlates with the finding whereby Taman Pandan Indah, has a total of sixty-six (66) of street turnings and twenty-eight (28) of street segments, as shown in Fig. 7 and 8. This result confirmed that the fragmented parallel street pattern correlates with high street segment and street turning that contribute to street crime

In order to conduct an observation using the CPTED checklist at the site, a 400-meter radius is used with a reference point at Jalan Pandan Indah 12 due to its high number of snatch theft cases in the area. This specific distance of 400 meters is used as the distance to show the risk of burglary is communicable [29] to be committed by the offenders. This indicator is acceptable as the guideline of reference point because it involves the context of the same field of crime and environment. In order to conduct the observation, Jalan Pandan Indah 12 has been selected because this street has the highest snatch theft cases in 2015 as shown in Figure 8. It has 6 hotspots of snatch theft in Jalan Pandan Indah 12, compared to Jalan Pandan Indah 18 – has 2 hotspots, Jalan Pandan Indah 16 – has 1 hotspot, Jalan Pandan Indah 19 – has 1 hotspot, Jalan Pandan Indah 20 – has 1 hotspot, and Jalan Pandan Indah 10 – has 1 hotspot. The observation in Jalan Pandan Indah 12 is shown in Fig. 9.

In this study, the observation uses four CPTED elements which are territoriality, surveillance, access control and maintenance and the result is shown in Table 2. Based on the result, the element of surveillance and access control are the main contributors of the snatch theft activities in Jalan Pandan Indah 12. However, [23] stated that sight distance, street width, the number of escape routes are several factors influencing snatches activities. Furthermore, this residential area is located between the Pandan Indah main road and the Light

Rapid Transit (LRT) rail station. Thus, this neighbourhood can be accessed by anyone especially to those who want to use the LRT facility. This is supported by [30] that the presence of transport hubs is one of the factors that influence snatch theft activities.

Table 2: CPTED observation checklist of Jalan Pandan Indah 112

Area	CPTED elements			
	Territoriality	Surveillance	Access Control (Escape route)	Maintenance
Point A	- no road signage	-blocking by vegetation - blocking by vehicles - blocking by house gate	4 escape route	- vandalism graffiti on the wall at firebreak - vegetation overgrown - Fire break lane do not have lamp post
Point B	- no road signage	- blocking by house gate	4 escape route	- vandalism graffiti on the wall at firebreak - vegetation overgrown - Fire break lane do not have lamp post
Point C	- no road signage	- blocking by vegetation - blocking by vehicles - blocking by house Gate	3 escape route	- Fire break lane do not have lamp post
Point D	- no road signage	- blocking by vegetation - blocking by vehicles - blocking by house Gate	2 escape route	- good condition – no rubbish around the street
Point E	- has street signage	- blocking by vehicles - blocking by house Gate	3 escape route	- good condition – no rubbish around the street
Point F	- has street signage	- blocking by vehicles - blocking by house Gate	3 escape route	- good condition – no rubbish around the street

4. Conclusion

This paper has presented street pattern identification for Crime Prevention through Environmental Design (CPTED) and confirmed that the fragmented parallel street pattern contributes to snatch theft activities. This study also confirmed that the street segment and street turning point also contribute to the crime. When there are more street segments and street turning points, there is a higher probability of snatch theft activities. Previous studies mostly found that snatch theft incidents tend to happen in the urban area such as commercial and public areas rather than the residential areas. However, in this study the hotspot of snatch theft activities happened in the residential area. This might be because the street design in the residential area has easy access and escape routes for the snatch theft offenders. Most of the streets in Pandan Indah are straight or linear street that are connected directly to the main road. Knowing this, the snatch theft offender uses the motorcycle because it is smaller than a car and easier for them to commit the crime. Due to this reason, it is easier for them to escape especially by using the smaller routes that cannot be accessed by bigger vehicles such as cars. The local authorities and all parties involved in the development need to ensure that the street pattern in the residential area does not use the fragmented parallel street pattern design. In the future, the relationship between the density and street pattern in relation to snatch theft cases need to be evaluated to create safe, liveable and sustainable cities.

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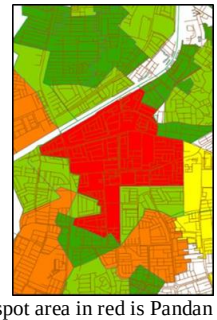


Fig. **4**: Hotspot area in red is Pandan Indah

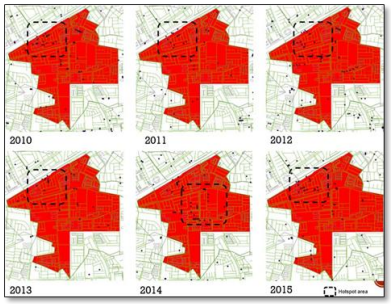


Fig. 5: Snatch Theft cases in Pandan Indah



Fig.6: Map of hotspot distribution in Taman Pandan Indah



Fig.7: Map of street segments that exist in Taman Pandan Indah



Fig.8: Map of street turnings that exist in Taman Pandan Indah

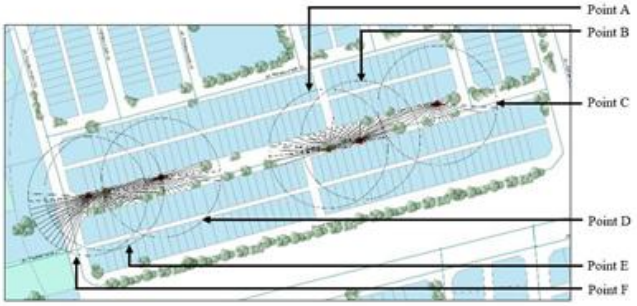


Fig.9: Visual map in Pandan Indah 12 based on street with high snatch theft spots in 2015