World Applied Sciences Journal 13 (8): 1948-1958, 2011
ISSN 1818-4952

Using Hotspot Mapping to Understand Spatial Patterns of Burglary in Residential Land Use: A Case Study of Penang

[1]M. Hedayati Marzbali, [1]A. Abdullah, [2]N.A. Razak and [1]M.J. Maghsoodi Tilaki

[1]School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Penang, Malaysia
[2]Schools of Educational Studies, Universiti Sains Malaysia, 11800 Penang, Malaysia

Abstract: Burglary is often concentrated at specific places and influenced by social and physical characteristics of the residents. More recently, the importance of identifying crime hotspots has been materialized with the purpose of reducing criminal activities using police resources and crime prevention strategies. The purpose of this exploratory study is to empirically examine spatial configuration of the urban environment and social permeability in relation to the occurrence of burglary in Penang, Malaysia. The study focuses on two types of police recorded crime data based on the Penal Code (Act 574): *housebreaking and theft by day* and *housebreaking and theft by night* for a period of a year between 2009-2010by producinga crime hotspots map. The crime mapping produced by this study is based on the street segment level. This article examines the distribution of residential burglary based on the crime pattern theory using both quantitative and qualitative research methods. A major finding of this study indicates that the Bayan Baru area in the south part of Penang has experienced among the highest level of residential burglary within the whole Island. This could be due to its proximity to an industrial zone and major roads, as well as being a working class neighbourhood comprising foreign workers with multi-ethnicity population compared to other middle or high-income areas located far from the industrial zone. The findings demonstrate thatthe degree of accessibility affects risks of burglary. Ultimately, the study suggests some recommendations that would contribute in reducing crime events in such areas.

Key words: Hotspots · Burglary · Residential · Malaysia · Crime map

INTRODUCTION

Urban population growth and development around the world have increased rapidly since the beginning of the Industrial Revolution [1]. Malaysia currently faces an extremely fast pace of development and similar to other more industrialized countries, it experiences many challenges that comes with this development such as escalating crime rates [2]. In spite of the fact that Malaysia is rapidly developing, Badaruddin [3] argues that social planning has been neglected and as a consequence, the country is facing many challenges. Issues such as the less cohesive relationship, isolation, increasing gap in family relations, higher individual freedom, problems of adjustment and increasing social distance have been associated with rapid urbanization in Malaysia [4]. According to the Malaysian Government Transformation Programme [5], the overall crime rate in Malaysia has increased from 746 reported crimes per 100,000 persons in 2006 to 767 in 2007 and 2008, a rise of nearly 3%. The extensive range of urban problems is blamed for the decrease of living conditions, which contributes to an increase in criminal events in urban settings.

However, the problem of crime and fear of crime becomes an obvious phenomenon today which may seriously undermine social welfare [6]. For any crime to occur, four dimensions must happen simultaneously: the victim or target, the specific location, the legal setting and the technical or mechanical requirements of the crime [7]. In the latter discussion, the Brantinghams considered the place as "a discrete location in time and space at which the other three dimensions intersect and a criminal event occurs" [7, 8]. According to the Chicago School of Sociology's researchers, both socioeconomic and physical factors of the environment contribute to the crime rate across neighbourhoods [8, 9].

Corresponding Author: M. Hedayati Marzbali, School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Penang, Malaysia.

A best understanding of crime refers to an interaction between the immediate environment and the offender [10]. McCord and Ratcliffe [11] argued that these prior studies were conducted at the macro-level scale, using aggregated data in order to analyze crime, while more recent studies have focused on the micro-level scale such as land uses, street corners and commercial establishments in the specific places. These micro-level analyses, indeed, consider crime opportunity to predict crime level.

Ratcliffe [12] in his work entitled 'Crime Mapping: Spatial and Temporal Challenges' emphasized on the importance of place, considering it as a fundamental selement in understanding crime. The physical crime analysis and numerous innovative approaches have materialized for identifying crime hotspotsthat has promoted the crime mapping approach to the fore, particularly regarding burglary and vehicular theft [13, 14]. Hotspots analysis is considered as a popular tool for behavioral and social science researches in urban and suburban environments [13]. Crime counts are used to assess crime locations (hot spot or cold spot) and police work loads, as well as to estimate needs for future resources [15]. It is believed that "areas of elevated crime are not random occurrences", while they are representative of specific factors such as economic, environmental, political and social factors in such areas [13, p 285]. However, research concerning crime hotspots found that declining socio-economic and environmental factors tend to motivate crime occurrences [16]. More recently, research has posited the enabling effect of the built environment on criminal activity, especially in hotspots [13].

There are two disciplines in relation to criminal activities: physical and social permeability. In relation to physical permeability, evidence suggests that spatial configuration of the built environment has high impacts on most of the everyday people's experiences such as movements, activities and their sense of being in an environment space [17]. The design of residential layouts affects day-to-day people's relationships and their living conditions. Furthermore, design features affect the quality of human life and the sustainability of urban areas, as well as the stability of people's lives. It is a fact that humans orient themselves vocationally to a range of subconscious and conscious responses to the environmental cues [18]. Indeed, reflection on anti-social behaviour is influenced by an area's social and spatial composition [19]. Bogaç [20] argued that the patterns of human behavior and their perceptions are the results of the mind's receiving, processing, storing and producing environmental information. On the other hand, a previous study suggested that the distribution of demographic characteristics may influence the generation of crime hotspots [21] as social aspects of crime. Criminologists always look for concentration of individual incidents as well as of specific areas having high crime and disorder rates [22]. Neighborhood's social dynamics may have an effect on residents' concerns regarding fear of crime [23]. A large portion of literature have posited that age and gender influence fear of crime, bringing forward that women and the elderly probably perceive a higher risk compared to men and younger people [24-28]. This may presumably refer to a lack of physical strength and less mobility for this group of people. A study conducted by Hedayati [29] in Penang, Malaysia found that although fear of crime is greater among female than male respondents, no evidence was found regarding the relationship between age and fear of crime. Social vulnerability supposed that increasing exposure to victimization tends to be more fearful. For instance, those living in a high crime neighbourhood, economically distressed and lacking enough resources to efficiently protect their houses are more likely to indicate the greater perceived social vulnerability [30, 31]. Many studies have shown that respondents belonging to ethnic minorities, with lower levels of education and higher poverty levels may perceive higher levels of fear of crime compared with their counterparts [28, 32-34]. A more recent study has demonstrated that there is a positive relationship between ethnic heterogeneity and crime risk at the neighbourhood level [35].

Generally, crime is not equally distributed among all segments of an area. Crime opportunities are not organized in a uniform or random manner within space and time [36]. Crime occurrence does not randomly happen, whereas it concentrates at certain areas due to some reasons referring to offenders, victims and the opportunities [37]. Certain places may have a higher probability of burglary incidents due to different environmental factors [38, 39]. The claim that crime often concentrates in particular places has been acknowledged by several studies [22, 35, 37]. This implies that certain places within an urban environment have higher crime rates rather than others due to the fact that crime opportunities are not equally exploitable within the whole area. A more recent study found that establishment of new industries has caused high demand of settlements and prompted low-cost housing in the cities' outskirts, especially for workers [40]. Obvious characteristics of such developments can be traced back to the increasing

crime rate, poverty and consequently people's fear of crime [41]. Crime clusters in some locations which are known as crime hotspots, while it appears to be absent in others [22]. Crime hotspot is defined as the area "of high crime concentration, relative to the distribution of crime across the whole region of interest" [42, p 147]. The present study examined two-type of property crime in Penang, Malaysia: housebreaking and theft by day and housebreaking and theft by night. These two types of crime are based on the Penal Code (Act 574) [43]. A general hypothesis refers to a non-uniformly distribution of residential burglary. This exploratory study seeks to examine the impact of the spatial and social permeability on individual crime sites based on the crime pattern theory. The data covered all incidences reported by the public between 2009-2010. A crime map was produced indicating the hotspots of the two crime types. The main objective of mapping crime is to identify places of high and low crime concentrations within the study area. In addition, it is useful to determine whether patterns of burglary varied between areas and were communicable across different areas. Ultimately, the study aims to examine burglary victimization in order to find crime hotspot area and present recommendations to increase public safety, in line with the recommendation by the National Key Result Areas (NKRA) in Malaysia. Research posited that crime and fear of crime must be considered at the initial stage of each development as effective indicators in achieving sustainability for communities [44].

Crime Pattern Theory: The current period is an innovation period in spatial analysis [45]. A limitation of spatial analysis of crime refers to the fact that prior researches do not represent a solid empirical foundation in terms of focusing on theory or practice in micro scales [46]. More recently, studies on geography of crime have increasingly focused their interest on smaller geographic units of analysis such as address level or street blocks [47]. Brantinghams [48] introduced three basic methods in order to identify crime hot spots namely: visual inspection, statistical identification and theoretical prediction. The knowledge of crime hot spots is necessary for purposes of crime prevention strategies [10, 48]. In terms of crime pattern, Ekblom [49] argued that it is aggregate crimes having common features, clustering in space and time, including specific targets. In this case, Brantinghams [50, p264] suggested that "crimes are patterned; decisions to commit crimes are patterned; and the process of committing a crime is patterned". Pattern theory contributes to understand crime patterns and criminal behaviour as well.

Patterns of crime may vary based on the scale of analysis such as a census tract or the city boundary [45]. According to Brantinghams and his colleagues [45], the unit of analysis is a critical and fundamental issue in any study; it can be employed in address level, aggregate data at a larger scale to evaluate crime pattern and again return to micro level in order to focus on patterns and the related information. In addition, Agung [51] suggested three alternative methods in order to analyze the temporal and spatial crime patterns for identification crime hot spot areas namely: counting the number of nearby crime incidents from each specific event, calculating the mean and standard deviation of time lag between two incidents and spatial concentration of incidents by determining the total distance of nearest incidents for each event.Weisburd *et al.* [46] conducted a micro-scale study in Seattle, WA for a period of 14-year, employed street segment as the unit of analysis, indicated crime concentrations over time. They suggested that central understanding overall crime trends refers to an understanding overall crime changes among specific groups of street segments [46].

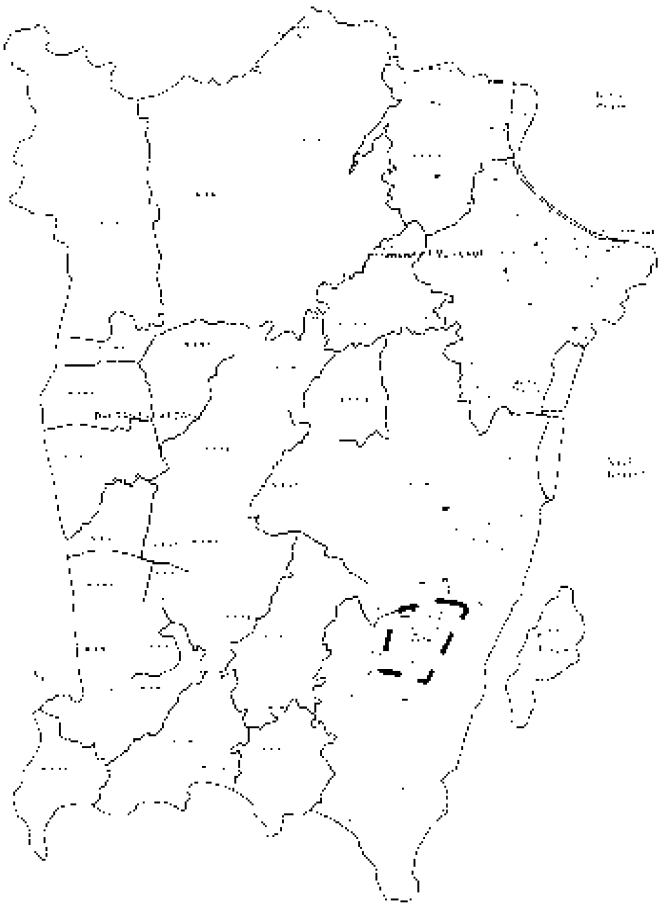
The Study Area: The study was conducted in Penang, Malaysia. Penang as the study area is one of the 13 states in the country, located on the Northwest coast of Peninsular Malaysia and stretching out 293 square kilometers. Penang is the second largest city in the country and has the second highest density of inhabitants per square kilometer [52]. According to the Department of Statistics Malaysia [53], the state of Penang has the density of 1,524 persons per square kilometer, but the Island part of the state (as the study area) has a density of 2,780 persons per square kilometer. This data shows a high density of population in the research area. There are culturally diverse populations residing in the study area. According to the Department of Statistics Malaysia [53], the state of Penang comprised 42% of Malay, 41% of Chinese, 10% Indian and only 7% represented other ethnic groups.It is home to one major university, a large community college, manufacturing and high-tech electronics plants on the southern part of the Island. The Malaysian Department of Statistics [53] indicates that over 741,300 people reside within the Island part of Penang in 2010. As the study focuses on residential neighbourhoods, it is important that the area chosen for the study consists of a good number of residential neighbourhoods. Having a large number of residential neighbourhoods could be an advantage to find a suitable area to meet the research criteria. According to the Royal Malaysian Police [54], the overall

recorded 'housebreaking and theft' has increased of a 15% from 2008 to 2009 in Penang. Penang is also accounted as one of the twelve crime hotspots in Malaysia [55].

MATERIALS AND METHODS

Data Collection: The current study employed official property crime statistics as a starting point for the explanation. The approach used was partially determined by the limitations of available information on crime. Although the police recorded crime incidents based on address points, access was only granted for the study to record reported crime in the study area at the street scale level. Therefore, a main limitation in the official crime statistics refers to the lack of the specific location of crime events during the mapping crime process. The data collection began in January 2010 and continued until March 2010 and was completed over a period of 50 days. In addition, some criminal secondary data were obtained from the Royal Malaysian Police reports.

Analytic Technique: At the initial stage, the study employed a quantitative approach using descriptive statistics in order to interpret the study findings. We explore the residential burglary pattern for 2009 for Penang Island. During 2009, more than 12,000 property criminal offences were reported to police in Penang. There were 935 residential burglaries by day and night reported to police in 2009 in the Island part of the state. There were 9,642 cases over the five year period from 2005 through 2009. The analysis technique involved two phases. The first phase develops a frequency table of burglary incidents based on Mukim(sub-district) as defined by the Town and Country Planning Department [56]. The second phase refers to the provision of the Penang crime map (refer to Map 1). Besides the statistical analysis, the crime data are mapped accordingto individual street level address. This allows investigation of any type of qualitative differences of spatial patterns of burglary that would not be able to examine it using statistical analysis. This method is adapted from a previous study conducted by Clontz [39]



Map 1: Penang crime map based on 2009-2010 burglary

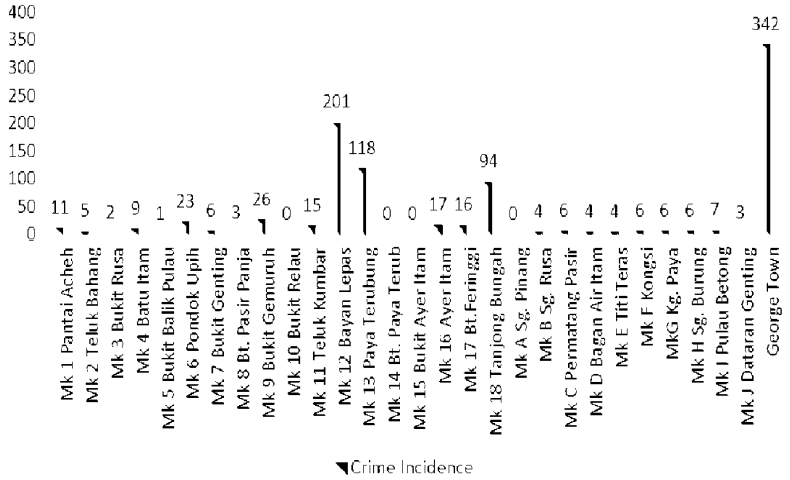
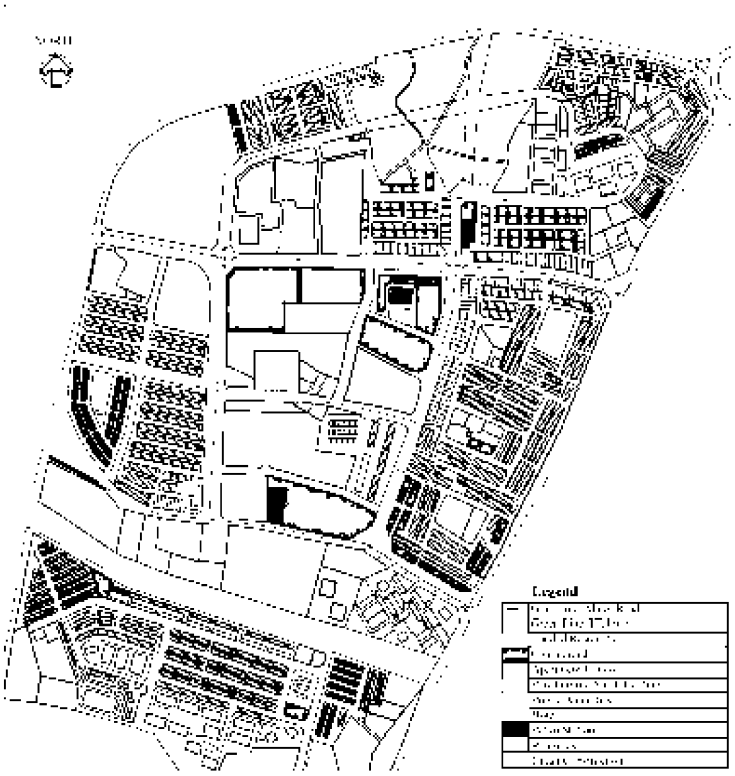


Table 1: Number of Penang burglary incidents during 2009-2010 according to sub-district (Mukim)

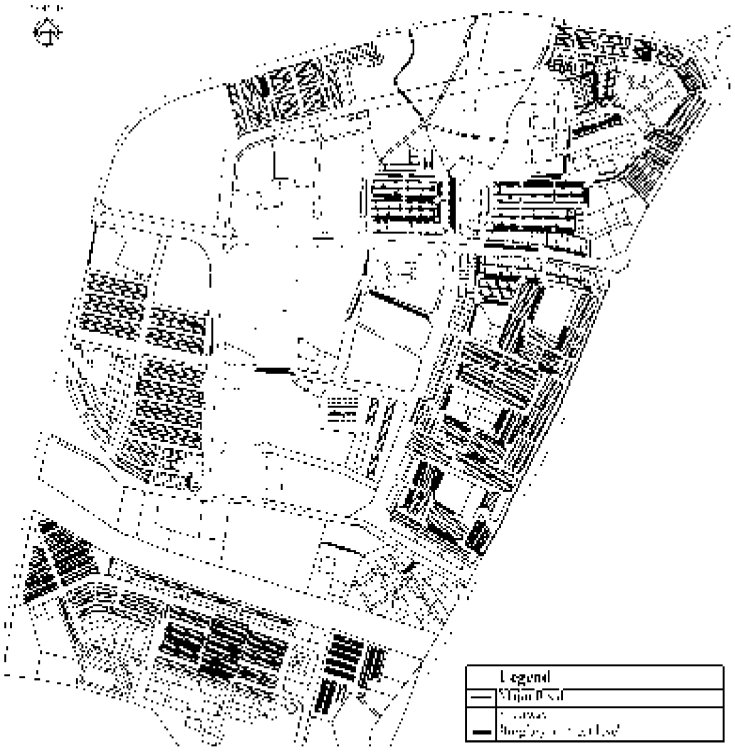
in an American context. Clontz [39] in his study employed a quantitative approach in order to analyze the data and consequently a qualitative method to focus on the spatial pattern analysis that was not identified quantitatively. In the crime mapping process, the study employed address of each burgled incident and made a mark on the map. It needs to be noted that in the Malaysian context, Mukim is a geographical division that is similar toa sub-district. The sub-district level is considered as one level below district. The Island part of Penang consists of 29 sub-districts. Another limitation of the available crime data can be referred to the lack of subdivision of the statistics by sub-districts. The smallest available crime statistics is at the district level. To overcome this limitation, the present study employed a systematic method to account burglary incidents by sub-district in the study area.

As depicts in Table 1, the study selected sub-district 12 (Bayan Lepas) as the second highest burglary incidents sub-district with an area of 31.85 square kilometers. The reason of selecting the second highest sub-districtis due to the fact that the highest crime incident sub-district (George Town) includes more commercial land uses rather than residential land use where most of the burglary cases involved residential shop lots. As the focus of this study is on residential area, thus, the second highest crime incidents sub-district was chosen for the analysis.

At the next stage, each sub-district was subdivided into residential neighbourhoods in order to examine crime hotspot among study areas. The study found the Bayan Baru neighbourhood with the highest crime density within the sub-district (refer to Map 2 and Map 3). The rapidly growing Bayan Baru suburb area is relatively far from the core city of Penang and is primarily residential for workers of south part of the Island industrial zone. It was observed that the street network in Bayan Baru is varied in nature. The Bayan Baru area is considered as a township located in Bayan Lepas area, established in the mid-1970 on what was paddy fields [57]. This working class neighbourhood is one of the most rapidly developed townships in Penang due to its proximity to the Bayan Lepas Free Industrial Zone. Following the expansion of industrial activity in the south part of the Island, the Bayan Baru neighbourhood was deemed popular among low to medium income workers. The movement pattern is dominated by private motor vehicles compared to public transport or pedestrian. The main road is Jalan Sultan Azlan Shah and includes the Bayan Lepas Elevated Highway. In recent years, a large portion of the population shifted from George Town into this area and has caused mixed reactions [57]. Although the majority of land use is a high density residential land use (more than 85%), there are schools, a shopping complex, a wet market, religious facilities, a private hospital and a few light industries. There are several hostels for foreign workers in this area. The results of the oral interview with a small sample of residents indicated that they are not satisfied with these hostels and they argued that beside a high rate of residential burglary, there are extremely high rate of snatch theft during early morning and dark hours. Most of the residents residing in the area for more than 5 years and they are living with their families. There are culturally diverse populations residing in Bayan Baru and Chinese people make up the majority of the population in this area. The other two main races are the Malay and Indian. There are a considerable portion of other ethnicities that work in the industrial zone.



Map 2: Bayan Baru neighbourhood map



Map 3: Map of the hotspots area at the street level

The area represents a landed housing development including typical medium-high (terraced) class housing and some low cost flats for the three main races.Typical house type is single-storey or double-storey terraced houses with the medium income level.

Crime Mapping: As noted, crime mapping technique was employed in this study to examine the distribution of burglary among the study area. According to Cozens [58] the mapping of crime distribution was initiated in the midst of the nineteenth century. It was supported by Garland [59] who stated that there was a long and continuous study of the so-called 'dangerous places' during the nineteenth century. It can be considered as a starting point towards developing crime prevention using design strategies. Crime prevention's methods and efforts to control crime through social and physical techniques increased rapidly during the 1970s. Jacobs [60] drew attention to the urban design and narrowed the investigation area of crime-space studies. In Jacobs' work, the focus was on specific elements of design that she posited may enhance the safety, while Angel [61] and Jeffery [62, 63] expanded the relationship between crime and urban design in terms of crime reduction approaches [64]. In recent years, crime hotspot mapping has become an analytical technique, determining where crime incidents to be highest, assisting the laws and the police to provide crime prevention resources for the future [37].

In crime mapping process, the most important thing to refer to is the selection of appropriate crime theory based on the specific objectives and data. Several studies have discussed the type of crime mapping based on the ease of use and interpretation [22, 36, 37]. There are different levels of theory in this case, namely place theory, street theory, neighbourhood theory, other large area theory and repeat victimization theory [22]. Eck [65] suggested that crime theories are considered as critical aspects for providing a useful crime map because they assist in the data interpretation. However, the absence of accurate addresses of burgled places leads this study to use the street theory in order to individuate crime mapping. This fact brings to conclude that the available units of burglary statistics are only at the street or block level, but not at the accurate place level. In light of these considerations, the study employs crime mapping based on the street level. Street theory demonstrates crime occurrence location at a slightly larger scale than the accurate location of crime events, such as streets and blocks [65]. In terms of Agung's [51] analytic methods, as the purpose of this study is to examine crime hot spot at the neighbourhood level, crime hot spot is identified based on the highest number of crime incident in a neighbourhood. Indeed, the present study used crime data at the smallest available level which is called the street level.

RESULTS

The result of the study indicates that based on the major burglary hotspot map from the 2009-2010 Royal Malaysian Police report for Penang identified a high proportion of *housebreaking and theft* occurring in the Bayan Baru area in the south part of the Island. There are different reasons in this regard. In the present study, two aspects of permeability are considered on burglary risk. The first aspect refers to the physical configuration of the area. Several studies have posited that crime clusters in space [66-68]. The number and types of neighbourhood problems is highly influenced by the surrounding environment such as the location of shop lots and schools that draws people in an area from all over the city [39]. It is believed that street permeability has a great effect on providing opportunities for offenders [35, 69-72] and spatial layout of the built environment and, in particular, type of street is an effective and pragmatic tool in reducing residential burglary [73]. Research found that in an aggregation of crime data, crime clusters in certain places such as major transit stops, schools and shopping areas [45].

Evidence suggests that the majority of the street segments in the area consists of grid street pattern with high permeability, indicating consistency with the literature. Another possible reason refers to the proximity to Penang industrial zone in the south part of the Island. Research concerned with providing opportunities for offenders, which indicated that burglary risk is associated with street permeability, has also suggested a higher burglary risk on more major roads or connected segments to them [36]. Therefore, the existence of major roads on and near the area provides more burglary vulnerability. In relation to physical aspects, research concerned with residential burglary conducted in five different countries, has found that homes within 200 m of a burgled house were associated with an increase of burglary risk for a period of at least two weeks [74].

A more detailed look at Map 2in micro-scale illustrates that although Bayan Baru area is considered as crime hotspot, but the majority of burglary incidents occurred in the intersections, grid pattern streets and those street segments close to the major roads, while the cul-de-sacs located in the southern part of the area have rarely experienced burglary. That is, streets with high

permeability and close to major roads have experienced high burglary incidents compared to low permeable streets, even though they have same demographic characteristics. Therefore, evidence suggested that in the study area restricted access for highly permeable streets by using bollards may effectively play important role in preventing burglary incidents as it can only facilitate local movements and sustainable transportation. The reason for selecting this micro-scale in crime pattern analysis refers to the fact that standard spatial aggregations of crime at the census tract (or in the present study at district or neighbourhood levels) fail to represent the fundamental spatial distributions of crime and social distributions of people [75].

The second aspect refers tothe social characteristics of the residents. Most of the previous literature on fear of crime has been focused on the socio-demographic characteristics as covariates of crime concerns, indicating that those groups that were believed to be more fearful than other groups - such as women, the poor, low income groups, less educated segments of society- in terms of being more physically and socially vulnerable [76]. Previous studies have indicated that living in poverty areas is associated with high crime vulnerability [77], due to the high rates of unemployment or low levels of education in such areas [78, 79]. Therefore, being a working class community can be a possible reason in terms of being crime hotspot in such area compared to other middle or high class neighbourhoods. Johnson and Bowers [35] also concluded that residents with high stability tended to have lower crime rates. They further suggested that elevated level of ethnic heterogeneity is positively associated with burglary risk at the neighbourhood level, where a 10% increase heterogeneity has increased a 26% burglary incidents. In addition, research found that ethnic heterogeneity plays an important role in offenders' decision making, whereas a more homogenous neighbourhoods seems to be associated with lower crime risk [74, 80]. Logic may imply that a similar approach can be deployed in the study hotspot, because multi-ethnicity workers are resided in the area. One major benefit of hotspots' identification refers to the determination of patterns of burglary in order to implement crime reduction strategies [74]. Indeed, the extent and the type of crime reduction strategies may highly determine by identification of crime distribution within an area.

Recommendations: The ultimate intention of the present study is to suggest some recommendations that would contributein crime reduction in the hotspot area. One possible way in crime reductionmay refer to the implementation crime prevention strategies such as Crime Prevention Through Environmental Design (CPTED). Several studies have found that CPTED is an effective and vital tool in reducing crime and provide safe communities [81]. In addition, research has identified four distinct factors that contributed to the variation of burglary pattern, namely surrounding area, household characteristics, immediate design and planning features and other aspects of lifestyle affecting the location [82]. In the light of the study area, it is suggested that if CPTED principles be incorporated at the planning, designing, or even redesigning processes of the built environment, it could be resulted a safer city and enhanced residents' perception of safety. It is believed that enhancing natural surveillance through security management, police patrolling, trimming landscape and security guard may decrease criminal activities. Residents must regularly maintain their access control devices such as locks, doors and fences that do not obstructed sight. Territorial reinforcement is also another important strategy in crime prevention programs. It gives a clear separation of public and private spaces which brings sense of ownership. Regular maintenance of the exterior environment inspires use of places. Evidence suggested that promoting a sense of community through activity generations may increase social cohesion and becomes active defenders of the places. Separation of pedestrian pathways from vehicular lanes may promote pedestrian walkability and enhance natural surveillance. In consistent with some tenants of CPTED and in line with a previous study [39], the present study does not encourage mixed land use zoning in residential areas. Researchers should continue to address more effective physical and social permeability's indicators of crime hotspots to identify appropriate strategies in order to reduce crime and fear of crime.

ACKNOWLEDGEMENTS

The authors would like to thank the Penang police Department (IPK Pulau Pinang) for providing the recorded burglary data analyzedand the School of Housing, Building and Planning (HBP), Universiti Sains Malaysia for providing financial support tothis study.

REFERENCES

1. Merrick, T., 1989. World population in transition. Population Bulletin, 41(2).

2. Wong, T.C., B.J. Shaw and K.C. Goh, 2006. Challenging sustainability: urban development and change in Southeast Asia. 2006, California: Marshall Cavendish Academic, 2nd edition.
3. Badaruddin, M., 2002. Planning for the Children of the Future-The Case of Malaysia. in Proceeding of Conference on Children and the City. Amman, Jordan.
4. Ibrahim, Y., 1995. PembandarandanKejiranan. Dewan Bahasadan Pustaka. Vol. 1. 1995, Kuala Lumpur: Ministry of Education.
5. Government Transformation Plan, Malaysian Government Transformation Plan Roadmap, P.M. Performance Management and Implementation Uni, Editor. 2010, National Printers Malaysia Berhad (PNMB): Putrajaya, pp: 40.
6. Knepper, P., 2009. How Situational Crime Prevention Contributes to Social Welfare. Liverpool Law Rev., 30: 57-75.
7. Brantingham, P.L. and P.J. Brantingham, 1981. Urban Crime and Environmental Criminology, ed. B. Hills. California: Sage, pp: 203-225.
8. Burgess, E.W., 1925. The Growth of the City, in The City R. Park, E.W. Burgess and R. McKenzie, Editors. The City University of Chicago Press Chicago: Chicago.
9. Shaw, C.R. and H.D. McKay, 1942. Juvenile delinquency and urban areas: A study of delinquents in relation to differential characteristics of local communities in American cities. Chicago University of Chicago Press.
10. Wortley, R. and L. Mazerolle, 2008. Environmental criminology and crime analysis. No.: ISBN 978-1-84392-280-3, pp: 315.
11. McCord, E.S. and J.H. Ratcliffe, 2009. Intensity Value Analysis and the Criminogenic Effects of Land Use Features on Local Crime Patterns.Crime Patterns and Analysis, 2(1).
12. Ratcliffe, J., 2010a. Crime Mapping: Spatial and temporal challenges, in Handbook of Quantitative Criminology, A.R. Piquero and D. Weisburd, Editors. Springer, pp: 5-24.
13. Grubesic, T.H. and E.A. Mack, 2008. Spatio-temporal interaction of urban crime. J. Quantitative Criminol., 24(3): 285-306.
14. Ratcliffe, J.H., 2002. Aoristic signatures and the spatio-temporal analysis of high volume crime patterns. J. Quantitative Criminol., 18(1): 23-43.
15. Brantingham, P.L. and P.J. Brantingham, 1998. Mapping crime for analytic purposes: location quotients, counts and rates. Crime Mapping and Crime Prevention, pp: 263-288.
16. Felson, M., 1994. Crime and everyday life: Insights and implications for society. No.: ISBN 0-8039-9029-4, pp: 182.
17. Hillier, B., J. Hanson and J. Peponis, 1987. Syntactic analysis of settlements. Architecture et Comportement/ Architecture and Behaviour, 3(3): 217-231.
18. Crowe, T.D., 2000. Crime prevention through environmental design: Applications of architectural design and space management concepts. second ed. Oxford: Butterworth-Heinemann.
19. Nes, A.V. and L. Rueb, 2009. Spatial Behaviour in Dutch Dwelling Areas- How Housing Layouts Affects the Behaviour of its Users. in 7th International Space Syntax Symposium. Stockholm.
20. Bogaç, C., 2009. Place attachment in a foreign settlement. J. Environmental Psychol., 29: 267-278.
21. Sorensen, D.W.M., 2003. The Nature and Prevention of Residential Burglary: A Review of the International Literature with An Eye Toward Prevention in Denmark.
22. Eck, J.E., *et al*., 2005. Mapping crime: Understanding hot spots. Washington: National Institute of Justice.
23. Austin, D.M., L.A. Furr and M. Spine, 2002. The effects of neighborhood conditions on perceptions of safety. J. Criminal Justice, 30(5): 417-427.
24. Ferraro, K.F. and R.L. LaGrange, 1992. Are older people most afraid of crime? Reconsidering age differences in fear of victimization. J. Gerontol., 47(5): S233-S244.
25. Fisher, B.S. and J.J. Sloan, 2003. Unraveling the fear of victimization among college women: Is the shadow of sexual assault hypothesis supported. Just. Q., 20: 633.
26. Hughes, P.P., D. Marshall and C. Sherrill, 2003. Multidimensional analysis of fear and confidence of university women relating to crimes and dangerous situations. J. Interpersonal Violence, 18(1): 33.
27. Keane, C., 1998. Evaluating the influence of fear of crime as an environmental mobility restrictor on women's routine activities. Environment and Behavior, 30(1): 60.
28. Taylor, R.B. and M. Hale, 1986. Testing alternative models of fear of crime. J. Criminal Law and Criminol., 77(1): 151-189.
29. Hedayati, M., 2009. Perception of Crime and an Assessment of Crime Prevention Through Environmental Design (CPTED) Elements in a Housing Area: A Case Study OF Minden Heights in Penang, in School of Housing, Building and Planning, Universiti Sains Malaysia: Penang, pp: 189.

30. Franklin, C.A. and T.W. Franklin, 2009. Predicting Fear of Crime: Considering Differences Across Gender. Feminist Criminol., 4(1): 83.
31. Franklin, T.W., C.A. Franklin and N.E. Fearn, 2008. A multilevel analysis of the vulnerability, disorder and social integration models of fear of crime. Social Justice Res., 21(2): 204-227.
32. Pantazis, C., 2000. 'Fear of Crime', Vulnerability and Poverty. British J. Criminol., 40(3): 414.
33. Parker, K.D. and A.B. Onyekwuluje, 1992. The Influence of Demographic and Economic Factors on Fear of Crime among African Americans. Western J. Black Studies, 16(3): 132-40.
34. Will, J.A. and J.H. McGrath, 1995. Crime, neighborhood perceptions and the underclass: The relationship between fear of crime and class position. J. Criminal Justice, 23(2): 163-176.
35. Johnson, S.D. and K.J. Bowers, 2010. Permeability and Burglary Risk: Are Cul-de-Sacs Safer? J. Quantitative Criminol., 26: 89-111.
36. Ratcliffe, J.H., 2010b. The spatial dependency of crime increase dispersion.Security J., 23(1): 18-36.
37. Chainey, S., L. Tompson and S. Uhlig, 2008. The utility of hotspot mapping for predicting spatial patterns of crime. Security J., 21(1): 4-28.
38. Brantingham, P.L. and P.J. Brantingham, 1978. A topological technique for regionalization. Environment and Behavior, 10(3): 335.
39. Clontz, K.A., 1997. Spatial Analysis of Residential Burglaries in Tallahassee, Florida. Paper presented at the Annual Environmental Systems Research Institute (ESRI).
40. Maghsoodi, M.J., *et al*., 2011. Challenges of the Informal Settlements in Developing Countries' Cities: A Case Study of Iran. World Applied Science Journal.
41. Richards, R., B. O'Leary and K. Mutsonziwa, 2007. Measuring quality of life in informal settlements in South Africa. Social Indicators Res., 81(2): 375-388.
42. Chainey, S. and J. Ratcliffe, 2005. GIS and Crime Mapping.
43. Penal Code, Act 574. 2006. The Commissioner of Law Revision, Malaysia: Kuala Lampur, Malaysia.
44. Hedayati, M., *et al*., 2011. A Review of the Effectiveness of Crime Prevention by Design Approaches towards Sustainable Development. J. Sustainable Development, 4(1).
45. Brantingham, P.L., *et al*., 2009. Crime analysis at multiple scales of aggregation: a topological approach, in *Putting Crime in its Place*, D. Weisburd, W. Bernasco and G. Bruinsma, Editors. Springer: New York, pp: 87-107.
46. Weisburd, D., *et al*., 2004. Trajectories of crime at places: A longitudinal study of street segments in the city of Seattle. Criminol., 42(2): 283-322.
47. Weisburd, D., G.J.N. Bruinsma and W. Bernasco, 2009. Units of analysis in geographic criminology: historical development, critical issues and open questions, in *Putting Crime in its Place*, D. Weisburd, W. Bernasco and G.J.N. Bruinsma, Editors. Springer, pp: 3-31.
48. Brantingham, P.L. and P.J. Brantingham, 1999. A theoretical model of crime hot spot generation. Studies on Crime and Crime Prevention, 8: 7-26.
49. Ekblom, P., 1988. Getting the best out of crime analysis. Home Office Crime Prevention Unit Paper 10. London: Home Office.
50. Brantingham, P.L. and P.J. Brantingham, 1993. Environment, routine and situation: toward a pattern theory of crime, in Routine activity and rational choice, R.V.G. Clarke and M. Felson, Editors. Transaction Publishers: New Jersey, pp: 259-294.
51. Agung, A.A.G., 1993. Crime Hot Spot Analysis and Dynamic Pin Map. in Spatial and Temporal Analysis of Crime: User Manual Illinois: Criminal Justice Information Authority.
52. Saw, S.H., 2007. The population of peninsular Malaysia. Institute of Southeast Asian Studies.
53. Department of Statistics Malaysia, Basic Population Characteristics By Administrative Districts, 2010. Department of Statistics, Malaysia: Putrajaya.
54. Royal Malaysian Police, Index Crime Statistics, in Police Headquarters, Police Department, 2010. Polis Diraja Malaysia (PDRM): Kuala Lampur, Bukit Aman.
55. Kam, R., 2010. 12 street crime hotspots get more CCTVs, in The Star. Star Publications (M) Bhd: Petaling Jaya, Kuala Lumpur.
56. Town and Country Planning Department, Total planning and development guidelines, T.a.C.P. Department, Editor, 2010. Town and Country Planning Department, Peninsular Malaysia: Kuala Lumpur, Malaysia.
57. Tye, T., 2010. Penang Travel Tips.
58. Cozens, P.M., 2002. Sustainable urban development and crime prevention through environmental design for the British city. Towards an effective urban environmentalism for the 21st century. Cities, 19(2): 129-137.
59. Garland, D., 1997. Of crimes and criminals: The development of criminology in Britain, in The Oxford handbook of criminology, M. Maguire, R. Morgan and R. Reiner, Editors. Clarendon Press: Oxford, pp: 11-56.

60. Jacobs, J., 1961. The Death and Life of Great American Cities. New York: Random House.
61. Angel, S., B. University of California and S. United, 1968. Discouraging crime through city planning. No.: WP-75, pp: 41.
62. Jeffery, C.R., 1969. Crime prevention and control through environmental engineering.Criminology, 7(3): 35-58.
63. Jeffery, C.R., 1971. Crime Prevention Through Environmental Design. Beverly Hills, CA: Sage.
64. Cozens, P., D. Hillier and G. Prescott, 2001. Crime and the design of residential property- exploring the theoretical background- Part 1.Property Management, 19(2): 136-164.
65. Eck, J.E., 1998. What do those dots mean? Mapping theories with data, in Crime mapping and crime prevention, D. Weisburd and T. McEwen, Editors. 1998, Criminal Justice Press: Monsey, NY., pp: 379-406.
66. Block, R.L. and C.R. Block, 1995. Space, place and crime: Hot spot areas and hot places of liquor-related crime. Crime and Place, 4: 145-184.
67. Ratcliffe, J.H. and M.J. McCullagh, 1998. Aoristic crime analysis. International J. Geographical Information Sci., 12(7): 751-764.
68. Sherman, L.W., P.R. Gartin and M.E. Buerger, 1989. Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place.Criminol., 27(1): 27-56.
69. Beavon, D.J.K., P.L. Brantingham and P.J. Brantingham, 1994. The influence of street networks on the patterning of property offenses. Crime Prevention Studies, 2: 115-148.
70. Newman, O., 1972. Defensible space; crime prevention through urban design, New York: Macmillan.
71. Poyner, B. and B. Webb, 1991. Crime Free Housing. United Kingdom: Butterworth Architecture, pp: 135.
72. White, G.F., 1990. Neighborhood permeability and burglary rates. Justice Quarterly, 7: 57.
73. Hedayati, M., A. Abdullah and M.J. Maghsoodi, 2010. Theory and Practice of Residential Areas' Street Configuration and Burglary Vulnerability: A Review of the Literature.International J. Organizational Innovation, 3(2- Fall 2010): 178-198.
74. Johnson, S.D., *et al*., 2007. Space-Time Patterns of Risk: A Cross National Assessment of Residential Burglary Victimization. J. Quantitative Criminol., 23(3): 201-219.
75. Schmid, C.F., 1960. Urban crime areas: Part II.American Sociological Review, 25(5): 655-678.
76. Rountree, P.W. and K.C. Land, 1996. Perceived Risk Versus Fear of Crime: Empirical Evidence of Conceptually Distinct Reaction in Survey Data. Social Forces, 74(4): 1353-1376.
77. Hillier, B., 2004. Can streets be made safe? Urban Design International, 9(1): 31-45.
78. Green, A. and D. Owen, 2006. The Geography of Poor Skills and Access to Work (Joseph Rowntree Foundation, York).
79. Spicker, P., 2003. Poor areas and the'ecological fallacy'. Radical Statistics, 76: 38-79.
80. Bernasco, W. and P. Nieuwbeerta, 2005. How Do Residential Burglars Select Target Areas?: A New Approach to the Analysis of Criminal Location Choice. British J. Criminol., 45(3): 296.
81. Cozens, P.M., G. Saville and D. Hillier, 2005. Crime prevention through environmental design (CPTED): a review and modern bibliography. Property Management, 23(5): 328-356.
82. Mawby, R.I., Burglary, 2001. Portland, United States: Willan Publishing, as cited by Moreto, W.D., Risk Factors of Urban Residential Burglary. RTM Insights, pp: 4.