Conceptualizing the application of Geographic information system in crime prevention through environmental design: CPTED+GIS

Molood Seifi, Aldrin Abdullah

Abstract— **Geographic information system (GIS) has already found vast popularity as a powerful tool for analyzing crime. The crime maps produced in GIS are mostly analyzed using criminological theories. Moreover, crime analysis outputs are often integrated into law enforcement for policing. However, the application of GIS in crime place theories and practices such as crime prevention through environmental design (CPTED) are rather rare. Simultaneously, CPTED needs a more robust tools to cope with its multivariate and intersecting measurement. Hence, the present study sought to conceptualize the method of implementation of GIS in CPTED in the context of university campuses. For this purpose, a thorough review of related literature was conducted. Conjointly, the possibilities of integrating both the systems were contemplated and analyzed. The result of this study showed that GIS is able to store and integrate the vast amount of physical and social data which is required for the comprehensive CPTED measurement. Moreover, the system is able to sort out where exactly the dimensions overlay, intersect, contrast or complement each other's effects through layering and converging the attributes of CPTED. The spatiotemporal analysis of GIS can analyze the changes in the built environment over time and assist CPTED to adapt with behavioral and environmental changes. Therefore, this paper concluded that GIS has the capacity to facilitate a major portion of what is lacked in existing CPTED evaluation processes and analysis. Although the paper envisages GIS+CPTED as the future of crime analysis activities in the built environment yet this tool is an experimental idea and not a panacea. Further empirical examination and integration of what has offered in this paper with other criminological theories and methods could ascertain the practicality of this tools for future applications.**

Keywords— **Through Environmental Design (CPTED); Geographic Information System (GIS), University Campus**

Professor Dr. Aldrin Abdullah *(Author)*
Universiti Sains Malaysia
Malaysia

Molood Seifi *(Corresponding Author)*
Universiti Sains Malaysia
Malaysia

I. Introduction

The repetitive occurrence of crime at certain places (crime hotspots) are a proof to the existence of problems with the physical and social fabric of such places which needs to be investigated. However, the ingredients of crimes are not straightforward [1]. Hence, scrutinizing more information about the crime place broadens our understanding of the relationships between physical features and crime.

Crime is inevitable, it can occur at any time and any place. Thus, University campuses same as other built environments are prone to crime. Currently, campus crime is a serious issue for "university students, parents of prospective students, campus law enforcement personnel, and the campus community as a whole including faculty and staff" [2]. The world has seen several university campus tragedies such as the sexual harassment at "Barry University in Miami Shores "in 1995. Hence, other universities have to start planning in advance and raise the level of security through available standards of the physical environment to prevent such crime incidences.
Extra patrolling the crime hotspots only displaces the crime to other areas within the campus. Hence, the real physical and social attributes of the crime hotspots need to be investigated. "Incorporating the principles and practices of CPTED in the design and remodeling of the physical environment can contribute to the safety of the campuses" [3]. CPTED measures the root causes of crime and it is a proven and pragmatic strategy to battle crime [4].

There are several security department in universities which have developed a campus security website empowered by geographic information system (GIS) capabilities. However, a limited number of universities have been sponsoring a security study of their campuses to ensure safety and prevent future risks of crimes; the example of Oregon University Safety Survey, United States (2000); and Barry University in Miami Shores, Florida, (1995). The focus of these campus studies has been on CPTED assessment and remodeling the physical environment, but they have not incorporated GIS to digitize the assessment of CPTED to help manage the spatial and social data and enable deeper analysis and predictions.

In addition, GIS is required to address the existing measurement issues of CPTED. According to [1] provision of in-depth baseline information is the essentiality to move CPTED forward as a science. Moreover, the study has

explored if GIS is able to deal with the problem of intersecting and overlapping dimensions of CPTED as mentioned by [5].
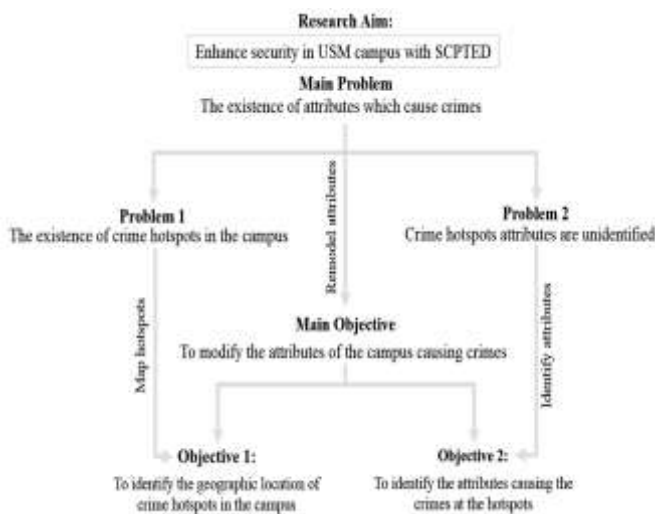
A. USM and Malaysia

Malaysia is one of the most rapidly urbanizing countries in Southeast Asia, and crime is amongst the issues relevant to the growth and development of this nation [6]. Crime has always been a leading concern of Malaysians and it appears first in the list of national key results area (NKRAs) of the government transformation program to move the country towards a developed nation by 2020 [7]; which was derived from a survey on citizens demands of the government [8].

University Sains Malaysia (USM) located at Penang Island; is one of the leading universities in Malaysia and highly recognized at international level. This university has the potential to set a benchmark for standardizing campus security to other universities and become a paradigm of safety and security. Figure 1 represents a systematic way of treating the attributes of

crime in university campuses.

Figure1. Framework to enhance security in University campus.

The USM campus is comprised of several land uses and on campus dormitories and strategic places such as CIMB banks which necessitate a high level of security. USM is a gated university and the flow of outsiders into the campus are controlled by the security but could not be completely avoided.

Although USM security department has a comprehensive 24-hour presence on campus but still there are some cases of crime within the campus. Often, there is a perception that extra policing of the hotspots displaces crime to other areas. Hence, the objective of this study is to treat the main causes of crime rather than providing extra policing. Figure 2 illustrates the map of Universiti Sains

Malaysia with some of the reported crime marked with red ellipses.

Figure 2. Map of Universiti Sains Malaysia with some of its crime spots.

I. GIS

Crime occurs at a place with geographical location, hence, knowing the place well helps in understanding and confronting crime. Likewise, exploring the geographical information about a place can explain crime in depth. Over the past two decades, computer-based mapping or geographic information system (GIS) has revolutionized the spatial planning of crime [9]. Moreover, the advancement in the spatial analysis by this tool has made a new phase of environmental criminology [10]. Hence, the application of GIS has been widespread in law enforcement agencies. Furthermore, mapping the number of crimes in location can label it as a hot spot or cold spot location which decides police work loads and need for future resources to combat crime [11].

A. Identifying Hotspots

Identifying the places where crime occurs the most makes crime prevention much easier as most of the prevention efforts could be focused on the hotspots [12].

A study by [13] shows that crime hotspots even exist on university campuses. Three theories are generally used to explain the hotspots of crime viz. rational choice theory, routine activity theory, and crime pattern theory [14]. The criminological theories are adopted to identify the hotspots of crimes mapped in GIS.

In addition to the criminological crime-place theories; CPTED which contains many of the perspectives of criminological theories is the immediate step to identify the attributes of the physical environment which cause crime.

II. CPTED

Changing the physical environment is one of the modern crime prevention approaches. The subject has been studied since 1961 by researchers; Jacobs [15]; Newman, [16]; Wilson and Kelling [17]; Lewis and Salem [18]; Taylor and Gottfredson [19]. A large body of research indicated, that modifications in the physical and social environment are essential and a primary in crime prevention. Eventually, all the concepts of environmental criminology developed the concept of CPTED which was first introduced by [20]. This concept involves space management, architectural design and urban planning of the built environments [21]. Moreover, second- generation CPTED added to first-generation embrace social analysis of crime [22]. Hence, CPTED is a complete strategy and its effectiveness as a pragmatic tool to reduce crime/victimization has been ascertained by many researchers in the field; [23] and [24].

The basic CPTED premise is that through the effective use and design of the built environment, there can be a reduction in the opportunity and fear of crime for attaining a better quality of life. Four main components of CPTED are Surveillance, Access control, Territoriality and Maintenance (SATM) (Cozen, 2002). The main dimensions of CPTED are not independent of each other; they interrelate, intersect, overlap and complement each other in many of their design concepts (Crowe, 2000). Some of the primary types of information required from a location in CPTED planning are crime analysis information, land use information, observation and demographic information (Crowe, 2000). Hence, it can be comprehended that architectural features, structural enhancements, and spatial definition can deter, detect, and delay potential violent offenders from entering school campuses and buildings.

A. GIS and CPTED

Geographic Information systems have been increasingly used to manage and display the variety of data and information about the crime places on maps. Although the concept of CPTED design has brought the attention back to the importance of spatial analysis of crime places [10] and GIS capabilities in spatial analysis are enormous, yet there are not many applications of GIS to assess CPTED. GIS has only been applied to map the crime data. But, its application must be extended to map the root causes of crime such as physical and socioeconomic of the living environment [10]. Moreover, the outputs of GIS crime mapping analysis are often integrated into the routine of policing and not sensible to build environment crime prevention practitioners. It is known that GIS and CPTED both have a focus in common and that is the spatial dimension of crime. Spatial dimension is marked to be an essential factor of each crime along with three more dimensions of the offender and legal setting and target of crime [26].

Moreover, the manual processes and traditional system of maintaining crime record have failed to "provide accurate, reliable and comprehensive data. Similarly, they do not help in "trend prediction and decision support" [27]. Therefore, the ultimate solution to this problem lies in effective use of technology. Geographic information System (GIS) enables the systematic mapping of CPTED dimensions and provides accessing, integrating, layering, and coordinating a vast amount of spatial data of crime hotspots.

The first step to explore why certain areas suffer from the persistent problem of crime is knowing where crime hotspots are located [10]. Subsequently, the CPTED of hotspots will further investigate the reasons behind the concentration of crime at the hotspots. However, the combination of CPTED and GIS to evaluate the attributes of crime hotspots has not been tried.

III. SCPTED Method

Systematized crime prevention through environmental design (SCPTED) is what has been lacking in previous CPTED measurements. Both qualitative and quantitative methods are required to collect accurate data for measuring CPTED. The mixed method comprises of survey questionnaires, site observation, GIS mapping and GIS spatial and demographic analysis. Table 1. Represent the stage one and two for achieving the objectives of achieving a safe campus.

TABLE I. Description of Data analysis to fulfil the objective of measuring CPTED by GIS in the University campus.
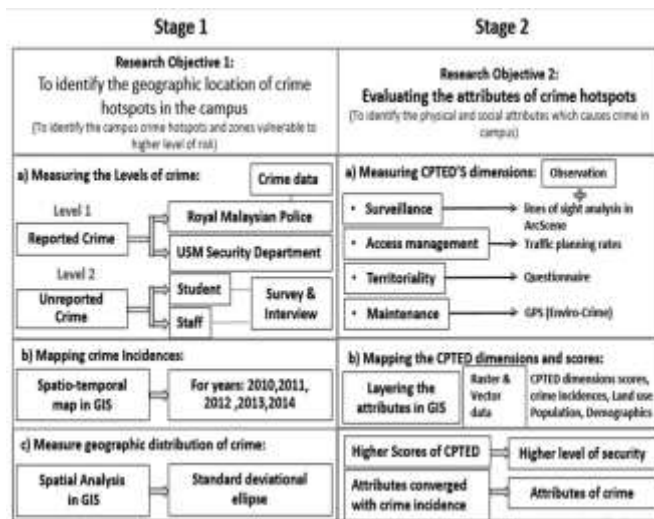
A. CPTED Assessment

A complete data collection compromises of both objective measurement and subjective measurement. Measuring the physical feature of the environment (objective measurement) and other by asking people (subjective measurement) [28]. In part one of data collection, students will answer the questions on the campus

website regarding their experience of crime within the campus.

Moreover, they will be asked to respond to the queries related to each dimension of CPTED. In part two of data collection, the physical attributes of CPTED is measured. An example of the questionnaire is depicted in table 2.

TABLE II. A sample of CPTED survey from everyone who reside in or study on USM campus.

CPTED measures	Related questions
Surveillance	Are you able to overview the street adjacent to your dormitory/classroom/ research room/laboratory?
Territoriality	If you notice an abnormal situation or noise will you report to the security department?
Access control	Is your place of study accessible to strangers?
Maintenance	Is the place of your work clean and well maintained?

Subsequent to the CPTED survey the reported crime experience can be mapped on the university campus by GIS. In addition to the question asked the individual building blocks and layout of the physical environment/roads will be observed for the same dimensions.

The CPTED measures will be marked by points, lines and polygons to identify the places of high/low CPTED scores. An example of the same is depicted in figure 1, marking the places of high survivability by the polygon in GIS. These data are collected through vector and raster data with the help of GPS photographs, and videos. Lastly, the entire data will be plotted on USM campus map using GIS.

1) *Surveillance*

There are three types of surveillance namely; natural, mechanical and organized [21] which can be measured through GIS and CPTED. Considering that natural surveillance within the campus refers to the people on campus streets or buildings who view the occurrence of crime. Mechanical surveillance is generally provided by Close Circuit Television cameras (CCTVs) to monitor various places and lightings to illuminate. Organized surveillance refers to the security guards which are in charge of creating safety within the campus.

Lighting has been shown as the most significant indicator of a safe parking garage in the evaluation of CPTED at the Ohio State University [29]. GIS can contribute in showing the effect of street-lighting on crime and fear of crime by providing lighting coverage maps along

with the specific location and types of lighting [30]. An example of GIS application in surveillance measurement is seen in Figure 3. Which illustrates how GIS marks the view span of CCTVs.
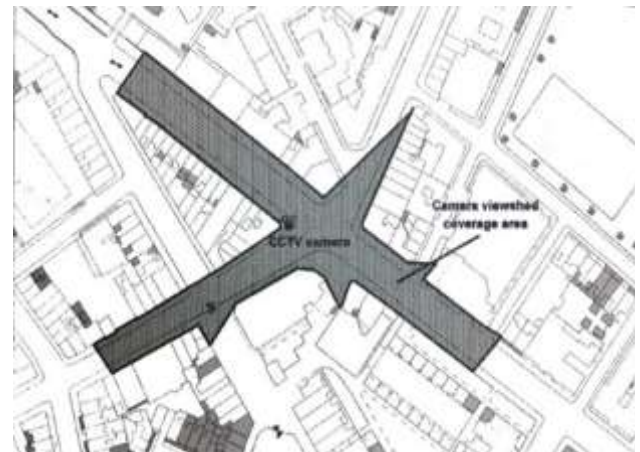

Figure3. The areas under the coverage of CCTV marked in GIS plan; adopted from [10].

In Figure 1 GIS polygon function has created the spatial object to show the location of sight view by CCTV. Similarly, the areas with a low degree of surveillability can be highlighted with polygons on surveillance layer of [31] also explored the use of GIS features such as ArcView for planning surveillance installations.

Besides mechanical surveillance Paterson and Boyle, [32] claimed that the existing view obstruction in urban settings leads to unsafe places which lack surveillance. Hence, the sightlines for the creation of opportunities for surveillance can be marked in GIS.

2) *Access Management*

The aim of access control is to discourage the presence of non-legitimate users of place by controlling the flow of vehicle and passersby. Empirical studies by [33] show that higher permeability of residential neighborhoods permitting more strangers increases the opportunities of property-related crimes. Hence, the access in such areas needs to be controlled.

On the other hand, the suburban and isolated areas suffer from disintegration and need to be provided by accessibility planning. In GIS, lines and dotted line are used to show the rate of accessibility of vehicles and pedestrian on each road. Once the traffic and pedestrian flow are rated, the decision for encouraging or discouraging population if those areas can be made. However, accessibility of people should not be confused by the accessibility of vehicles that instead increases the escapability of criminals [34].

[35] Have discussed the Integration of space syntax into GIS. Moreover, the combination of GIS and Space syntax

has been used to conduct geographic accessibility analysis such as [36]. Hence, the accessibility and access control features of CPTED can be evaluated through GIS analysis.

3) *Territoriality*

Territorial reinforcement uses the physical elements and certain activities to promote the sense of proprietorship in legitimate users of the environment [21]. Moreover, it creates some perception of risk in potential offenders.

[18] Believed in demarcating urban areas which are under the influence of inhabitants to create territorial attitudes. Hence, zoning of urban spaces into private, public, semi-public and semi-private were introduced. This idea was based on the private and public space concept by [17]. The demarcation of territorial definitions and boundaries are the important part of Territoriality dimension of CPTED. GIS can carry out the zoning and marking of urban spaces. There are few examples such as [37] that describes a GIS-based land use zoning that is applicable for territorial marking.

4) *Maintenance*

CPTED site analysis includes all the features of maintenance such as "lighting, upkeep, graffiti pattern, and levels of decay or renovation" [1]. [38] discussed the effective use of technologies such as a combination of GIS and GPS to report graffiti, fly-tipping, and vandalism and other types of 'envirocrime'. Moreover, GPS cameras linked with GIS were used to map and photograph graffiti on bridges [39]. Marking the areas of high maintenance and low maintenance with points and polygons.

5) *Land Use*

Although University campuses are considered as 'Institutional Land Use' as whole, but they are composed of different types of land uses i.e. residential (hostels), recreational (café), commercials (stores: uptown mall, CIMB bank,), transportation (bus stops and roads) and open land uses (vacant plots). Since, different types of land use attract different types of crimes then each parcel's land use information has to be stored precisely for analysis of crime. A study by [40] indicated that petty crimes and drug abuse concentrated in residential and commercial land uses.

IV. Data Merging

The merging of individual CPTED information layers in GIS helps to understand the extent of each CPTED measures effectiveness on the level of crime. The power of GIS lays in its ability to integrate, manage and analyze a disparate range of data [41]. The integration of GIS and CPTED constructs a robust tool which is able to investigate myriad correlations of physical and socioeconomic characteristics of the environment with the crime. When GIS layers are placed on top of one another, spatial trends

and relationships can be detected. Individual scores of CPTED's dimensions, the crime incidents of different types, demographics, population densities, land use types as illustrated in Figure 1.

Figure 3. Convergence of GIS information layers Adapted from [10].

The model consists primarily of the creation of several geographic information system (GIS) data layers depicting attributes related to the dimensions of CPTED and other necessary information. Spatial data layers could include the following: Parcels, Zoning (Public, semi-public, private), Imagery, Transportation, Street data, Building data, vegetation/landscape data, Block population, Traffic densities, Land ownership and boundaries. The base maps are the physical environment including the buildings, landscapes, road layouts and other infrastructures. The CPTED information stored in the form of GIS layers can be grouped in different numbers and types of layers according to required analysis. Layers can be easily added or removed.

V. Conclusion

GIS+CPTED (SCPTED) can be developed by a collaborative effort of software developers, GIS professionals, and CPTED professionals. However, empirical evaluation of CPTED through GIS must be carried out to check the accuracy of measurement and refine the offered method to ascertain the practicality of combining GIS and CPTED.

In addition, considering the fact that CPTED has been developed in another part of the world and the transferability of CPTED to non-western context is believed to be questionable [42, 43]. CPTED professionals must be selective when it comes to applying the suitable dimensions and guidelines of CPTED to the local context. For instance,

the frequency of armed violence committed with the use of guns are more frequently seen in university campuses of the western countries but not in the Malaysian context. Similarly serial sex attacks on the university campus (Cubbage and Smith, 2009). Thus, the extent and nature of on-campus crimes are not the same in various countries even the similar ones to the US and the UK (Fisher and Wilkes, 2003). Therefore, CPTED must be applied considering the local culture and the types of crime which are experienced.

Moreover, for SCPTED to be marketed as a tool for crime analysis the CPTED functions have to be designed as a built-in-program which is easy and feasible to use. The Combination of CPTED and GIS seems to be adding to the analytical sophistications of crime. However, SCPTED brings us one step closer to the untangling of spider web mentioned by Schneider and Kitchen (2002) (P158) to evaluate the effectiveness of CPTED measures for a specific place and type of crime.

The practicality of applying GIS to map and analyze the dimensions of CPTED was highlighted in this study through few examples of its previous applications. This study concludes that GIS has a wide potential to take CPTED measurement and analysis to another level through its mapping outputs and merging layers. However, there is a need for a further detailed investigation to promote more inclusive knowledge about SCPTED.

Acknowledgement

References

[1] R. Atlas, "21st century security and CPTED," Boca Raton, Florida: CRS Press. 2008, http://www. crcpress. com.

[2] W.G. Jennings, A. R. Gover, and D. Pudrzynska, "Are institutions of higher learning safe? A descriptive study of campus safety issues and self‐reported campus victimization among male and female college students," Journal of Criminal Justice Education, 2007, 18(2): p. 191-208.

[3] R. Atlas, and S. Young, "ABCs of CPTED: A Florida University Applied Principles of Crime Prevention Through Environmental Design To Create a Safer Campus," Campus Safety Journal, 2002, 10(8): p. 48-51.

[4] P.M. Cozens, G. Saville, and D. Hillier, "Crime prevention through environmental design (CPTED): a review and modern bibliography," Property management, 2005, 23(5): p. 328-356.

[5] P. Ekblom, "Deconstructing CPTED… and reconstructing it for practice, knowledge management and research," European Journal on Criminal Policy and Research, 2011, 17(1): p. 7-28.

[6] T. C. Wong, B. J. Shaw, and K. C. Goh, "Challenging sustainability: Urban development and change in Southeast Asia," Marshall Cavendish International, 2006.

[7] 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.

[8] S. Foster, M. Knuiman, L. Wood, and B. Giles-Corti, "Suburban neighbourhood design: Associations with fear of crime versus perceived crime risk," Journal of Environmental Psychology, 2013, 36, 112-117.

[9] D. Weisburd, and T. McEwen, "Crime mapping and crime prevention." Criminal Justice Press New York, 1998.

[10] Chainey, S. and J. Ratcliffe, GIS and crime mapping. 2005: John Wiley & Sons.

[11] P. L. Brantingham, and P. J. Brantingham, "Mapping crime for analytic purposes: location quotients, counts and rates," Crime mapping and crime prevention, 1998. 8: p. 263-288.

[12] G. F. Rengert, M.T. Mattson, and K.D. Henderson, "Campus security: situational crime prevention in high-density environments," Criminal Justice Press Monsey, 2001.

[13] G. Rengert, and R. Lowell, "Combating campus crime with mapping and analysis," Crime Mapp News, 2005. 7(1): p. 1-5.

[14] Robinson, M.B. and K.L. Mullen, Crime on campus: a survey of space users. Crime Prevention and Community Safety, 2001. 3(4): p. 33-46.

[15] J. Jacobs, "The death and life of great American cities," 1961: Vintage.

[16] O. Newman, "Defensible spac," Macmillan New York, 1972.

[17] J. Q. Wilson, and G.L. Kelling, "Broken windows," Atlantic monthly, 1982. 249(3): p. 29-38.

[18] D. A. Lewis, and G. Salem, "Fear of crime: Incivility and the production of a social problem,"Transaction Books New Brunswick, NJ, 1986.

[19] R. B. Taylor, and S. Gottfredson, "Environmental design, crime, and prevention: An examination of community dynamics," Crime and justice, 1986: p. 387-416.

[20] C. Jeffery, Ray, "Crime Prevention Through Environmental Design," Beverly Hills. CA: Sage, 1971.

[21] T. D. Crowe, "Crime prevention through environmental design: Applications of architectural design and space management concepts," Butterworth-Heinemann, 2000.

[22] G. Saville, and G. Cleveland, "Second-Generation CPTED. 21st Century Security and CPTED: Designing for Critical Infrastructure Protection and Crime Prevention", 2010: p. 79.

[23] P. Cozens, D. Hillier, and G. Prescott, "Crime and the design of residential property–exploring the theoretical background-Part 1," Property management, 2001. 19(2): p. 136-164.

[24] J. R. Minnery, and B. Lim, "Measuring crime prevention through environmental design," Journal of architectural and planning research, 2005, 22(4): p. 330-341.

[25] P. Cozens, "Sustainable urban development and crime prevention through environmental design for the British city. Towards an effective urban environmentalism for the 21st century," Cities, 2002. 19(2): p. 129-137.

[26] P.L. Brantingham, and P.J. Brangtingham, "Environmental Criminology," Sage Publications, Beverly Hills, CA, 1991.

[27] C. Johnson, "Crime mapping and analysis using GIS," in Geomatics Conference on Geomatics in Electronic Governance, January, 2000.

[28] P. Perez, "Modelling urban liveability", TEDxUWollongong, Retrieved from https://www.youtube.com/watch?v=qNF4SgHxKVQ, 2013.

[29] C. H. Tseng, , J. Duane, and F. Hadipriono, "Performance of campus parking garages in preventing crime," Journal of Performance of Constructed Facilities, 2004, 18(1), 21-28.

[30] R. Pain, R. MacFarlane, K. Turner, and S. Gill, "When, where, if, and but': qualifying GIS and the effect of streetlighting on crime and fear," Environment and Planning A, 38(11), 2055, 2006.

[31] S. Rana, "Use of gis for planning visual surveillance installations," 2005.

[32] R.W. Paterson, and K. J. Boyle, "Out of sight, out of mind? Using GIS to incorporate visibility in hedonic property value models," Land economics, 2002, 78(3): p. 417-425.

[33] D. J. Beavon, P. L. Brantingham, and P. J. Brantingham, "The influence of street networks on the patterning of property offenses," Crime prevention studies, 1994, 2: p. 115-148.

[34] Seifi, M. Abdullah, "Territriality versus natural surveillance: conflicting elements in design of residential areas against burglary," UM-COHAS International Conference, University of Malaya, Kuala Lumpur, Malaysia, 2015.

[35] B. Jiang, and C. Claramunt, "Integration of space syntax into GIS: new perspectives for urban morphology," Transactions in GIS, 2002, 6(3): p. 295-309.

[36] L. Nubani, "Targets for crime: measuring the spatial and visual attributes of crime locations using space syntax," the University of Michigan," 2006.

[37] F. T. Lin, "GIS-based information flow in a land-use zoning review process," Landscape and urban planning, 2000, 52(1): p. 21-32.

[38] D. I. Ashby, B. L. Irving, and P. A. Longley, "Police reform and the new public management paradigm: matching technology to the rhetoric," Environment and Planning C: Government and Policy, 2007, 25(2): p. 159.

[39] S. Egilmez, "How to Analyze and Battle Incidents of Graffiti: CGrAS--Citywide Graffiti Abatement System," Crime Mapping News, 2004, 6(2): p. 2-3.

[40] A. N. M. Ludin, N. A. Aziz, N. H. Yusoff, and W. J. W. A. Razak, "Impacts of urban land use on crime patterns through GIS application," Planning Malaysia, 2013, 11, 1-22.

[41] P. Longley, "Geographic information systems and science," John Wiley & Sons, 2005.

[42] P. Ekblom, R. Armitage, L. Monchuk, and B. Castell, "Crime Prevention Through Environmental Design in the United Arab Emirates: A Suitable Case for Reorientation?," Built Environment, 2013, 39(1), 92-113.

[43] P. Cozens and P. Melenhorst, "Exploring Community Perceptions of Crime and Crime Prevention through Environmental Design (CPTED) in Botswana," Paper presented at the Papers from the British Criminology Conference, 2014.

[44] C. J. Cubbage, and C. L. Smith, "The function of security in reducing women's fear of crime in open public spaces: A case study of serial sex attacks at a Western Australian university," Security Journal, 2009, 22(1): p. 73-86.

[45] B. S. Fisher, and A. R. Wilkes, "A tale of two ivory towers. A comparative analysis of victimization rates and risks between university students in the United States and England," British Journal of Criminology, 2003. 43(3): p. 526-545.

[46] R. H. Schneider, and T. Kitchen, "Planning for crime prevention: A transatlantic perspective," 2002, Spon Press.