# NATURAL AND MECHANICAL SECURITY ATTRIBUTES FOR HOUSE BREAK-IN PREVENTION IN PENANG HOTSPOTS

**MOLOOD SEIFI**

**UNIVERSITI SAINS MALAYSIA**

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# NATURAL AND MECHANICAL SECURITY ATTRIBUTES FOR HOUSE BREAK-IN PREVENTION IN PENANG HOTSPOTS

**by**

**MOLOOD SEIFI**

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I dedicate this thesis to the "new me" who has survived the test of time.

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| Abbreviations | Full Forms |
|---|---|
| AB | Actual Barrier |
| ACO | Access Control of Openings |
| A | Alarms |
| BCS | British Crime Survey |
| CCTV | Closed Circuit Television |
| CPTED | Crime Prevention Through Environmental Design |
| CV | Courtyard View |
| EV | Entrance View |
| HBI | House Break-in |
| HBIP | House Break-in Prevention |
| HL | House Lighting |
| L | Locks |
| LANDV | Landscape View |
| MCPTEDH | Mechanical CPTED at House level |
| MACC | Mechanical Access Control |
| MMAINT | Mechanical Maintenance |
| MMAE | Mechanical Maintenance of Architectural Elements |
| MMLE | Mechanical Maintenance of Landscape Elements |
| MSD | Mechanical Spatial Definition |
| MSURV | Mechanical Surveillance |
| MTDH | Mechanical Territorial Display of House |
| MTERRT | Mechanical Territoriality |
| NACC | Natural Access Control |
| NCPTED | Natural CPTED |
| NMAE | Natural Maintenance of Architectural Elements |
| NMLE | Natural Maintenance of Landscape Elements |
| NMAINT | Natural Maintenance |
| NSURV | Natural Surveillance |
| NTERRT | Natural Territoriality |

| | |
|---|---|
| PTH | Permanent Territorial Display of House |
| SB | Security Bar |
| SBD | Secured By Design |
| SDH | Spatial Definition of House |
| SO | Signs of Occupancy |
| STERRT | Social Territoriality |
| WV | Windows View |

**KAJIAN CIRI-CIRI ASPEK KESELAMATAN SEMULAJADI DAN MEKANIKAL BAGI PENCEGAHAN PECAH RUMAH DI KAWASAN JENAYAH TINGGI DI PULAU PINANG**

## ABSTRAK

Pengetahuan secara meluas telah menyokong keberkesanan pencegahan jenayah melalui reka bentuk alam sekitar (CPTED) pada pencegahan jenayah pecah rumah. CPTED terdiri daripada sifat semulajadi yang disediakan dengan mereka bentuk elemen-elemen rumah sedemikian rupa untuk mencegah jenayah pecah rumah dan sifat-sifat mekanikal yang termasuk selepas pemasangan keselamatan seperti penggera dan CCTV. Walau bagaimanapun, kebanyakan kajian menumpukan kepada kesan keseluruhan CPTED pada jenayah pecah rumah. Para Penyelidik telah terlepas pandang indikator kesan individu semulajadi, mekanikal dan dimensi CPTED. Oleh itu, penyelidikan yang lebih komprehensif diperlukan untuk meneroka kesan semulajadi CPTED berbanding CPTED mekanikal. Oleh itu, kajian ini mengkaji kesan indikator semulajadi dan mekanikal dan dimensi CPTED terhadap pencegahan jenayah pecah rumah. Menurut sorotan kajian, data yang sesuai untuk kajian sedemikian boleh diperolehi dari perumahan jenis berkembar yang terletak di kawasan jenayah tinggi yang boleh menarik lebih banyak insiden jenayah pecah rumah. Maka, data pecah rumah dari ibu pejabat polis Pulau Pinang telah dipetakan dan dianalisis dengan menggunakan sistem maklumat geografi (GIS) dan teknik analisis kawasan-kawasan jenayah tinggi. Hasilnya, kawasan kejiranan A dipilih sebagai kawasan kajian yang mempunyai bilangan demografi penduduk yang tinggi di kawasan rumah berkembar. Tinjauan soal selidik telah dijalankan kepada 194

penduduk yang dipilih secara rawak dan hanya 57% daripadanya menjawab soal selidik tersebut. Selain itu, 111 soal selidik telah dikembalikan dari mana 106 telah lengkap dan boleh digunakan. Teknik *Partial Least Square-Structural Equation Modelling* yang menggunakan perisian WarpPLS 6.0 digunakan untuk menganalisis data. Keputusan analisis menunjukkan bahawa petunjuk semulajadi CPTED mempunyai kesan yang signifikan dalam mencegah jenayah pecah rumah. Sebaliknya, kebanyakan daripada indikator mekanikal tidak berkesan dimana hanya 3 daripada 10 indikator, iaitu pencahayaan rumah, penyelenggaraan mekanikal unsur-unsur seni bina dan lanskap yang mempunyai kesan yang kecil terhadap pencegahan jenayah pecah rumah. Selain itu, semua dimensi semulajadi CPTED, iaitu Natural Surveillance, Natural Access Control, Natural Territoriality, Natural Maintenance dan Social Territoriality mempunyai kesan yang signifikan terhadap pencegahan jenayah pecah rumah. Sebaliknya, di antara dimensi mekanikal CPTED hanya kawalan akses mekanikal dan penyelenggaraan mekanikal mempunyai kesan yang kecil terhadap jenayah pecah rumah. Kajian ini mengesahkan bahawa CPTED adalah model keempat, Formative Construct Model dengan dua strategi utama iaitu indikator CPTED semulajadi dan mekanikal CPTED dengan sembilan dimensi semulajadi, Social and Mechanical Dimensions, Namely, Natural Surveillance, natural Access Control, Natural Territoriality, Natural Maintenance, Social Territoriality, Mechanical Surveillance, Mechanical Access Control, Mechanical Territoriality and Mechanical Maintenance dengan dua puluh satu indikator semulajadi dan indikator mekanikal yang ada di dalamnya. Model kajian ini boleh meramalkan 45 peratus daripada pencegahan jenayah pecah rumah yang secara statistik dianggap sangat tinggi dan belum dicapai oleh kajian lain sehingga kini. Selain itu, hasil daripada model struktur adalah selaras dengan sorotan kajian sedia

ada yang mendapati CPTED secara keseluruhan berkesan untuk menghalang jenayah pecah rumah. Kajian ini menyimpulkan bahawa walaupun hasilnya tidak menyokong penyatuan diantara pencegahan CPTED mekanikal dan pencegahan jenayah pecah rumah secara keseluruhan, beberapa indikator mekanikal dan dimensi tertentu CPTED ditunjukkan mempunyai kesan yang kecil terhadap pencegahan pencegahan rumah dan memainkan peranan penting dalam meramalkan jenayah pecah rumah bersama dengan indikator semula jadi dan dimensi. Oleh itu, kajian masa depan perlu mengukur keberkesanan indikator semulajadi dan mekanikal dan dimensi CPTED secara individu dan secara kolektif untuk mencapai hasil keputusan yang lebih realistik. Sumbangan utama kajian ini ialah memperluaskan teori CPTED dengan mengubahnya sebagai model keempat, hierarki formatif yang dapat mengukur keberkesanan CPTED bagi indikator semulajadi dan mekanikal serta indikator individu serta dimensi mereka dalam pencegahan jenayah pecah rumah. Secara praktikalnya, penemuan kajian ini menyumbang kepada peningkatan pengetahuan mengenai ciri-ciri keselamatan kerja dalam mencegah jenayah pecah rumah untuk jenis perumahan yang serupa dengan konteks yang sama. Implikasi yang paling penting dalam kajian ini adalah untuk meningkatkan keselamatan rumah-rumah berkembar di Malaysia terhadap jenayah pecah rumah. Kajian ini mencadangkan penilaian CPTED yang lebih luas termasuk tahap jalan, aplikasi dalam jenis harta tanah yang lain, dan membandingkan pelaksanaan pra dan pasca CPTED.

# NATURAL AND MECHANICAL SECURITY ATTRIBUTES FOR HOUSE BREAK-IN PREVENTION IN PENANG HOTSPOTS

## ABSTRACT

An extensive body of knowledge supports the effectiveness of crime prevention through environmental design (CPTED) on house break-in prevention. CPTED consists of natural attributes which are provided by designing the elements of the house in such a way to prevent break-ins and mechanical attributes which include after built security installations such as alarms and CCTV. However, most studies have focused on the overall effect of CPTED on house break-ins. They have overlooked the individual effects of the natural & mechanical indicators & dimensions of CPTED. Therefore, more comprehensive research is required to explore the effect of natural CPTED versus mechanical CPTED. Hence, this study examined the impact of the natural and mechanical indicators and dimensions of CPTED on house break-in prevention. According to the literature, the ideal data for such a study could be obtained from the detached houses located on the hotspots which attract a higher number of break-in incidences. Hence, the house break-in data from the Penang Island's police headquarter was mapped and analysed using the geographic information system and hotspot analysis technique. Consequently, neighbourhood A was selected as the study area possessing a high demographic number of detached houses. A questionnaire survey was administered to 194 randomly selected residents of the neighbourhood out of which 57% responded. 111 questionnaires were returned out of which 106 were complete and usable. The partial least square-structural equation modelling technique using the WarpPLS 6.0 software

was employed to analyse the data. The results of the analysis showed that the natural indicators of CPTED have a significant effect in preventing house break-ins. On the contrary, the mechanical indicators of CPTED were mostly ineffective with only 3 out of 10 indicators, namely house lighting, and mechanical maintenance of architectural and landscape elements having a small significant effect on house break-in prevention. Besides, all the natural dimensions of CPTED, namely natural surveillance, natural access control, natural territoriality, natural maintenance, social territoriality have a significant effect on house break-in prevention. On the other hand, amongst the mechanical dimensions of CPTED only mechanical access control and mechanical maintenance have a small significant effect on house break-ins. The study confirms that CPTED predicting house break-in prevention is a fourth-order, formative construct model with two main strategies, namely natural CPTED and mechanical CPTED with nine natural, social and mechanical dimensions, namely, natural surveillance, natural access control, natural territoriality, natural maintenance, social territoriality, mechanical surveillance, mechanical access control, mechanical territoriality, and mechanical maintenance with twenty-one natural and mechanical indicators nested within them. The model of the present study can predict 45 per cent of the house break-in prevention which statistically considered high and has not been achieved by any other study to the date. Besides, the results of the structural model were in alignment with the existing literature that found overall CPTED to be effective in preventing house break-ins. The study concludes that certain mechanical indicators and dimensions of CPTED were shown to have a small significant effect on the house break-in prevention and play an important role in predicting house break-ins along with the natural indicators and dimensions. Therefore, future studies need to measure the effectiveness of the natural and mechanical indicators and

dimensions of CPTED individually and collectively to arrive at more realistic results. The main contribution of the present study is extending the theory of CPTED by reframing it as a fourth-order, formative hierarchical model which can measure the effectiveness of the natural and mechanical CPTED and their indicators and dimensions on house break-in prevention. On a more practical level, the findings of this study contributed to the expanding of knowledge concerning which attributes of security work in preventing house break-ins for similar housing types with similar context. The most important implication of this study is to enhance the security of the detached houses in Malaysia against break-ins. The study suggests a broader assessment of CPTED including street level, application in other types of landed property, and comparing the pre and post implementation of CPTED.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Research

Crime is defined as a forbidden act or an activity against the public law that is harmful to some individual or community which violates the legal code and makes the offender liable to punishment (Tappan, 1960). The six common types of crimes are (1) crimes against persons or personal crime which include robbery, rape, assault, and murder; (2) crimes against property such as house theft or burglary, arson, larceny, and auto theft which involve no bodily harm; (3) hate crimes which is against person or properties caused by hate towards each other's religion, ethnicity, sexual orientation, gender, or race; (4) crimes against morality such as illegal drug use, gambling and prostitution; (5) white-collar crimes which are committed by the people of high social status such as tax evasion; and (6) organized crimes are committed by a group of people which control large illegal enterprises such as weapons smuggling and money laundering.

According to the crime statistics of 64 countries as reported by the United Nations, 72% of the crimes are against property. Similarly, in Malaysia, property crimes are 81% of the total reported crimes with residential burglaries being on top of the list (Sindhu, 2005). "Residential burglary" also known as "house break-in" (HBI) is the illegal entry to a house (Moreto, 2010; Ratcliffe, 2001) through an open door, windows, gate, etc. or break-in forcibly to commit a felony or to steal any property from any area within the premises of the house. Even though house break-in

might appear to be less severe than other types of crimes, but research has proven that the psychological effects of it are not lesser than assault, robbery, other types of violent crimes (Hough, 1984). It also has a severe adverse impact on the economy and people's quality of life hence, needs to be prevented (Crowe, 2000).

According to the American National Crime Prevention Institute, crime prevention is the anticipation, recognition and appraisal of a crime risk and the initiation of some action to remove or reduce it. There are several social, psychological, and biological theories of crime, but none have provided a comprehensive understanding of the cause of this phenomenon. The most popular crime prevention concept was proposed by Clark (1997) who posited that the focus of crime prevention must be on the design, manipulation and management of the immediate environment rather than those committing criminal activities. This debate was later named as "design effect crime" which was mainly concerned with the attributes of the built environment that discourage crime (Eck & Clark, 2003).

Eventually all the debates related to the design effects crime laid the foundation of the theory of crime prevention through environmental design. The term 'CPTED' was first coined by Jeffery (1971). The theory draws on the idea that proper design and effective use of the built environment can lead to the reduction in opportunities for crime (Crowe, 2000). CPTED consists of four major design concepts, namely surveillance, access control, territoriality and maintenance (Cozens et al., 2001). Surveillance design enables the legitimate users of the space and passers-by to observes the target and convey the message to the criminals that it is under surveillance and the offenders are being seen. Access control design restricts the access to the target of crime through physical barriers and security installations.

Territoriality design defines the boundaries of a target to generate a sense of authority in the legitimate users and fear in potential offenders. Maintenance design keeps the target and its environment well maintained to send environmental cues to the criminals that the target is being taken care of and is difficult to be subjected to crime.

The research on CPTED was initially concerned with finding the attributes of built forms that prevent crime (Clark & Eck, 2003). So, it mainly involved space management, architectural design, and urban planning (Crowe, 2000). In the following years, each concept of CPTED evolved into natural and mechanical dimensions. According to Crowe (2000), the natural dimensions are the by-product of the natural and routine use of the environment and are closely related to the physical design. Whereas, the mechanical dimensions involve the use of target hardening, security installations and mostly are added to the built space.

Crowe (2000) further explained the difference between the natural and mechanical dimensions by referring to the windows of the house as the elements which provide natural surveillance and CCTV (closed circuit television) as mechanical surveillance. Moreover, he noted that the spatial definition of a house would contribute to the natural access control dimension whereas, elements such as locks help to mechanically control the access to the house. In this manner, the concepts of CPTED were divided into four natural dimensions, namely natural surveillance, natural access control, natural territoriality, and natural maintenance. The design concepts were then further divided into four mechanical dimensions, namely mechanical surveillance, mechanical access control, mechanical territoriality, and mechanical maintenance. Figure 1.1 summarises the concepts and dimensions of

CPTED extracted from Crowe (2000). Each concept and dimensions of CPTED are further explained in chapter two (literature review).

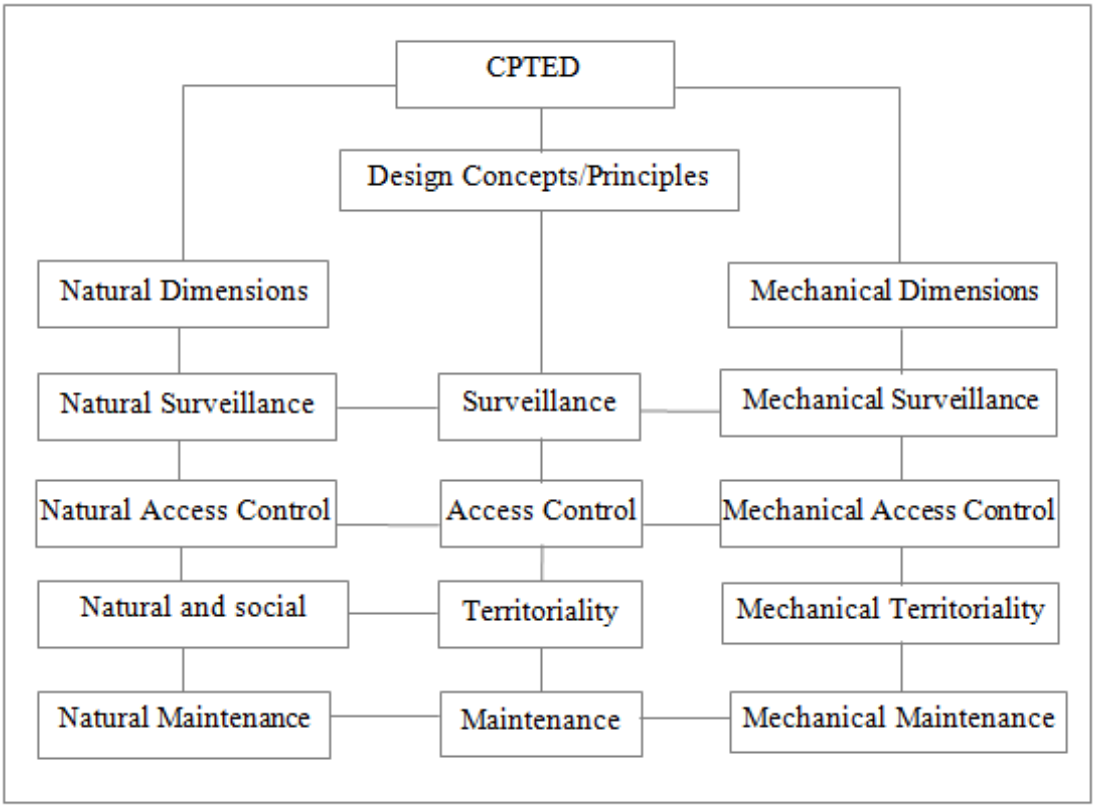


Figure 1.1 The concepts and dimensions of CPTED adapted from Crowe (2000)

CPTED enjoyed a flourish of support in the early 1970s, and the primary evidence on the effectiveness of the theories design concepts belongs to the first few decades of its evolution (Cohen, 2014; Gibson & Johnson, 2013). In the following years, some studies showed that CPTED's design concepts reduce crime in residential settings while others did not support the claim that CPTED is effective (Cozens & Love, 2015). Taylore (2002) noted that the finding of research which provided evidence for the success of CPTED was varied and mostly inconclusive. However, several studies such as Sorensen (2003), Minnery and Lim (2005), Marzbali et al. (2012) and Morgan et al. (2014) provided a high amount of reliable

evidence for CPTED's design concepts in reducing house break-ins. Therefore, there is a good deal of support on the effectiveness of CPTED in lowering crime in residential settings (Morgan et al., 2014).

Even though a large body of knowledge confirms the effectiveness and pragmatically of the individual design concepts of CPTED in reducing house break-ins (Cozens et al., 2001), research has provided very little evidence on the success of the theory as a whole (Cozens et al., 2005). According to Marzbali et al. (2016), most of the studies have measured the effectiveness of one or more concepts of CPTED, but not all of them simultaneously. For instance, Armitage (2007) and Armitage et al. (2010) focused on surveillance concept or Brown and Altman (1983) and Nee and Meenaghan (2006) measured the effect of territoriality on house break-ins. Similarly, all the following researches: Crowe (2000), Cozens et al. (2001), Schneider and Kitchen (2002), Parnaby (2007), Foster et al. (2010), and Abdullah et al. (2013a) measured the impact of few concepts of CPTED rather than testing all of them together. Very few studies measured all the four concepts, namely surveillance, access control, territoriality, and maintenance simultaneously in a single context (e.g., Minnery& Lim, 2005; Marzbali et al., 2012; Marzbali et al., 2016).

The major drawback of the studies which measured the concepts of CPTED simultaneously is that they combined the effects of the natural and mechanical dimensions. Thus, there is very little knowledge on the efficacy of the natural dimensions and mechanical dimensions separately on house break-in prevention. For instance, Armitage (2006a), Minnery and Lim (2005), Marzbali et al (2012), and Marzbali et al. (2016) combined the effects of natural surveillance dimension (houses overlooked by neighbouring properties) and the mechanical surveillance dimension

(lighting) on house break-in prevention which makes it difficult to estimate the real effect of each dimension on house break-in prevention. According to Ekblom (2009), very few studies have measured the effectiveness of all the dimensions of CPTED simultaneously in a single context. Therefore, there is a need to measure the effectiveness of natural and mechanical dimensions of CPTED, both individually and in combination on house break-in prevention.

## 1.2 Problem Statement

Undeniably, evaluating the effectiveness of specific place-based crime prevention dimensions are as difficult as untangling a spider's web (Schneider & Kitchen, 2002). The difficulty in the evaluation of CPTED comes from its complex nature consisting of various natural and mechanical dimensions and indicators (Ekblom, 2011). Thus, measuring the basic concepts of CPTED are not enough on their own (Cozens, 2014). In fact, research on CPTED needs to be comprehensive enough to include both the natural and mechanical dimensions and indicators to overcome the current evaluation complexity (Cozens & Love, 2015).

Despite the attempt by the CPTED practitioners to incorporate the natural dimensions into the design of houses (Cozens and Love, 2015), the residents continue to rely mostly on the mechanical dimensions to protect their houses against house break-ins. For instance, the residents prefer the usage of CCTV over the natural surveillance through their house windows or they have more faith in the burglar alarms rather than a well-designed boundary wall of their houses. Therefore, the comparison between the effectiveness of natural and mechanical dimensions and indicators could provide evidence to prove what works in a specific context to prevent house break-ins.

To date, very few studies have been conducted to evaluate the extent of the effectiveness of natural dimensions as compared to the mechanical dimension of CPTED on house break-in prevention. Cozens et al. (2001) believed that the comparison between natural and mechanical dimensions is one of the aspects of CPTED research which has been neglected and requires further investigation. Similarly, Crowe (2000) suggested that studies need to compare the effectiveness of natural CPTED and mechanical CPTED. The main reason for finding the extent of effectiveness of natural dimensions without the interference of the effectiveness of mechanical dimensions and vice versa helps to determine the choice and appropriate mix of CPTED dimensions to prevent house break-ins (DUAP, 2000). Figure 1.2 demonstrates the complexity of CPTED in the form of a spider web.

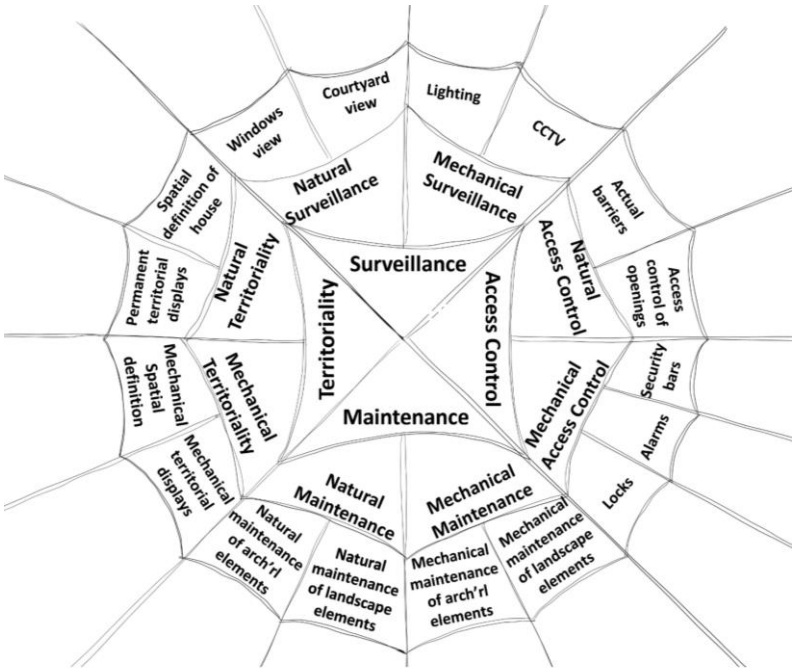


Figure 1.2 Spider web showing the combination of the concepts, dimensions and indicators of CPTED

Even though Minnery and Lim (2005), Marzbali et al. (2012), Marzbali et al. (2016), and Raynald (2014) have found the effectiveness related to each dimension

of CPTED, they combined the effect of natural and mechanical dimensions. In fact, a little scope is offered for singling out the effects of natural and mechanical dimensions and indicators of CPTED. Therefore, clearing up the ambiguity surrounding the effectiveness of the natural CPTED and mechanical CPTED could be solved by thorough examination and comparison of the individual and collective effect of its dimensions and indicators on house break-in prevention.

## 1.3 Research Questions

The questions of the present study revolved around the effects of natural CPTED and mechanical CPTED on house break-in prevention. The research must find the answers to the three following questions to attain the purpose of the study.

1. What are the effects of the natural and mechanical indicators of CPTED on house break-in prevention?
2. What are the effects of the natural and mechanical dimensions of CPTED on house break-in prevention?
3. Is natural CPTED more effective in preventing house break-ins or mechanical CPTED?

## 1.4 Research Purpose and Objectives

This study aims to develop and test a model of relationships between CPTED and house break-in prevention consisting of natural CPTED and mechanical CPTED. The three objectives of the present study to attain the aim of the research are as follows:

1. To examine the effects of the natural and mechanical indicators of CPTED on house break-in prevention.

2. To examine the effects of the natural and mechanical dimensions of CPTED on house break-in prevention.
3. To identify whether natural CPTED is more effective in preventing house break-ins or mechanical CPTED.

Objective 1 seeks to examine the relationship of the natural and mechanical indicators of CPTED which are the natural and mechanical security attributes of the houses with house break-in prevention. The study measures the extent of the existence of natural and mechanical indicators of CPTED in the detached houses of the study area. The twenty-one indicators are nested within the nine dimensions of CPTED. For instance, the study examines the individual effects of the four indicators of the natural surveillance dimension, namely courtyard visibility, windows view, entrance visibility, and landscape visibility on house break-in prevention. Therefore, through objective one, the current study identifies which indicators of CPTED or the natural and mechanical security attributes of the detached houses of the the study area are more effective in preventing break-ins.

In addition, Objective 2 of the study examines the effect of the nine dimensions of CPTED, namely natural surveillance, natural access control, natural territoriality, social territoriality, natural maintenance, mechanical surveillance, mechanical access control, mechanical territoriality, and mechanical maintenance on break-in prevention of the detached houses of the study area. Finally, Objective 3 seeks to find out whether natural CPTED is more effective in preventing house break-in or mechanical CPTED.

## 1.5 The Significance of the Research

The significance of the present research comes from its remarkable contribution to the body of knowledge by addressing the identified gap in the field of CPTED which is to investigate whether natural CPTED is more effective in preventing house break-ins or mechanical CPTED. Hence, the significance of this study lays in the development, validation and implementation of a robust tool which combines the natural and mechanical indicators and dimensions of CPTED to examine their effect on house break-in prevention. Therefore, this study is one of the first to measure the individual and combined effect of the natural and mechanical indicators and dimensions of CPTED on house break-in prevention.

## 1.6 The Definition of Key Terms

This section provides the definition of the key terms used in the present study. However, chapter two explains the following terms in detail.

*House break-in:* It refers to the breaking and entering a dwelling with intent to commit a felony therein. This term is a substitute for the most commonly used word, residential burglary. The term break-in is more accurate for the studies which count in the attempted break-ins into the premises of the house during day or night even if nothing was stolen or taken away such as the present study. House break-in to commit residential burglary is further explained in chapter two section 2.12. According to the Panel Code: Act 574), (2009) the intruders trespass the house in the following five ways, all of them are considered as house break-in in the present study.

a) If he enters or quits through a passage made by himself or by any abettor of the house-trespass for committing house-trespass.

b) If he enters or quits through a passage not intended by any person, other than himself or an abettor of the offence, for human entrance; or through any passage to which he has obtained access by scaling or climbing over any wall or building.

c) If he enters or quits through any passage which he or any abettor of the house-trespass has opened, to the committing of the house-trespass, by means by which that passage was not intended by the occupier of the house to be opened.

d) If he enters or leaves by opening any lock for committing of the house-trespass, or to the quitting of the house after a house-trespass.

e) If he enters or quits by any passage which he knows to have been fastened against such entrance or departure and to have unfastened by himself or by an abettor of the house-trespass.

*Crime prevention through environmental design (CPTED):* CPTED premises on the idea that crime is linked to physical features of the environment and not solely predicted on individual, structural, or institutional measures (Cohen, 2014). It is the process of designing security into architecture (Atlas, 2008). This concept involves space management, architectural design, urban planning and effective use of the built space that leads to the reduction of crime (Crowe, 2000) as well as social analysis of crime (Saville & Cleveland, 2010) and mechanical security. CPTED consists of natural CPTED and mechanical CPTED. Four design concepts of CPTED are surveillance, access control, territoriality, and maintenance (Cozens et al., 2002).

*Natural crime prevention through environmental design (NCPTED):* Natural CPTED is the by-product of the normal and routine use of the environment (Crowe, 2000). It is based on the idea that the design of the houses must adapt or create an environment to accomplish security instead of relying on mechanical installations. Thus, mostly the architecture and planning are involved in creating the natural attributes of security such as designing the windows to provide a good view of the courtyard and street instead of installing CCTVs. In the present study, natural indicators of CPTED or natural security attributes are the architectural components or inherent features of the house which exist naturally and have the capability to prevent break-ins.

*Mechanical crime prevention through environmental (MCPTED):* Mechanical CPTED refers to the artificial techniques of CPTED (Crowe, 2000). Cozens (2014) included the indicators of the mechanical CPTED in his most recent and popular framework of CPTED. In contrast with natural CPTED, mechanical CPTED is not related to the design of the built environment and mostly involves after built security installations. The most common example of the mechanical indicator of CPTED is the usage of CCTV in the house to provide mechanical surveillance and locks/alarms for controlling access to the house mechanically rather than the use of boundary walls.

*Natural and mechanical surveillance:* Smith (1996) defines surveillance as "the ability to observe one's surroundings." Surveillance design maximises the ability of the users of the space (Formal: security guards, police, employees) or informal (residents, passers-by, shoppers) to observe suspicious behaviour (Armitage, 2013). Typically, surveillance has two classifications namely, natural (e.g., residents' self-

surveillance opportunities as facilitated by windows) and mechanical (e.g., lighting and CCTV).

In recent years, the break-in prevention practices emphasise the implementation of the combination of natural and mechanical dimensions. Natural surveillance is the physical design that provides a clear line of sight to residents for observing their house and surrounding areas. Whereas, the mechanical techniques relie on the artificial installations such as lighting and CCTV to promote surveillance. Armitage (2013) referred to lighting as security lighting following the secured by design scheme (SBD) that names mechanical CPTED as physical security. The perception that any house with any design could possess adequate surveillance if equipped with many CCTV cameras does not seem promising as there are houses with many of them which have been burgled. On the contrary, there are houses with no CCTV which have not yet been burgled. Therefore, the effectiveness of natural surveillance versus mechanical surveillance on house break-in prevention needs to be investigated.

*Natural and mechanical access Control:* These two dimensions of CPTED reduce the opportunities for break-ins by limiting access to the house and creating a high perception of risk to trespassers while entering the property. Access control restricts entry to the legitimate users of the space through designed elements (Levinson, 2002). Traditionally, mechanical access control (target hardening) was used for denying access to the target with physical barriers such as fences, gates, locks, electronic alarms and security patrols (Cozen et al., 2005). In the present study, the use of physical design barriers such as boundary walls is referred to as

natural access control and the mechanical installations to control access such as alarms are considered as mechanical access control.

*Natural and mechanical territoriality:* Territoriality, also known as territorial reinforcement was the key design element of Newman's defensible concept which was based on the idea that physical design can increase the sense of ownership in the residents and create fear in intruders (Armitage, 2013). It employs the physical elements, mechanical strategies, and social factors or specific activities to create a sphere of territorial influence which sends risk cues of being seen (or reported) to potential offenders (Crowe, 2000; Atlas, 2008; Saville & Cleveland, 2008). Hence, territoriality facilitates the control of the residents over their environment and discourages the presence of non-legitimate users of space.

Research on territoriality is "fraught with difficulties associated with definition and measurement" (Cozens et al., 2005). Researchers need to understand that both surveillance and access control facilitate "a sense of territoriality" (Atlas, 2008). However, to identify the independent effect of territoriality on house break-in, the measuring indicators of it should not overlap with those of surveillance and access control. Based on the explanations given by Newman (1996), Atlas (2008), and Saville and Cleveland, (2008), the territoriality concept of CPTED consists of two dimensions, namely natural territoriality (NTERRT) which includes physical and social aspects and mechanical territoriality (MTERRT).

*Natural and mechanical maintenance:* The significance of the relationship between the physical condition or the "image" of the built environment and crime and the fear of crime has long been acknowledged (Lynch, 1960). In fact, the image which offenders have of a living environment is related to the level of crime in that

area (Taylor, 1987). The ‘‘maintenance’’ (image management) concept of CPTED was developed by the Newman’s (1972) ‘‘image and milieu’’ concept and the Broken Windows theory by Wilson and Kelling (1982) which posited that the less maintained areas are at higher risk of burglaries (Curtin et al., 2001; Taylor, 2001; Weisburd et al., 2012). In other words, for a space to be crime free, it must look well cared for and maintained up to the appropriate standard (Atlas, 2008).

A well-maintained house shows that the owner cares for it and sends risk cues to the potential offenders. On the contrary, a poorly maintained home encourages crime as it sends the signal to the offender that no one cares for space. Hence, natural and mechanical maintenance aim at promoting a positive image of the physical environment which allows its effective use (Cozens & Love, 2015). Natural maintenance mostly depends on the architect’s choice of the architectural and landscape elements which relatively require a lower level of maintenance. For instance, an exposed concrete wall does not require paint or frequent maintenance as compared to a brick masonry wall. On the other hand, mechanical maintenance is related to the effort of the residents in up keeping their living environment through frequent cleaning and repairing the architectural and landscape elements.

## 1.7 Research Methodology

The methodology of the present research is two parts which are explained briefly in this section with a detailed discussion in Chapter 3. The first step to explore why specific areas suffer from the persistent problem of crime is knowing where crime hotspots are located (Chainey & Ratcliffe, 2005). Thus, before measuring the effectiveness of CPTED dimensions and indicators on house break-ins; the geographical location of break-ins hotspots in Penang Island were identified.

Using geographic information systems (GIS), 1,486 property crime incidents (including house break-in cases) were mapped and analysed using Getis-Ord Gi* spatial Statistics and average nearest neighbour technique to generate the hotspots. In addition, the average nearest neighbour tool was deployed to determine the spatial patterns of house break-ins and property crimes for the years 2011-2013 (the latest data provided by Police Headquarter Penang Island). Consequently, the study area named as neighbourhood A was selected among the neighbourhoods located on the hotspots of house break-ins. Other than being located on the hotspots neighbourhood A had to possess the following characteristics (1) a high portion of landed properties, (2) a high number of detached houses, and (3) medium-high socio-economic demography.

The second part of the study employs a deductive approach (quantitative research) to attain the research objectives. According to Sakip and Abdullah (2017), CPTED measurement must apply both the questionnaire survey and observation for better results. Hence, this research administrated a questionnaire survey (face-to-face) and observation items (mostly developed from the scholarly works) in neighbourhood A, Penang Island. The population for the study includes all the detached houses (along with the householders) located within the study area. This study utilises a systematic sampling with the random start method at intervals of every third unit to select samples from the population. Subsequently, the study used structural equation modelling (PLS-SEM) to analyse the collected data.

## 1.8 Overview of the Chapters

This section provides an overview of the chapters of the present thesis to describe the flow of the conducted research. This thesis is composed of a total of six

chapters. Chapter One consists of an introduction, the background of the research, problem statement, research purpose and objectives, research questions, the significance of the research, the definition of key terms, research methodology, and an overview of the chapters.

Chapter Two composes of two parts, one part of the chapter reviews the literature to understand the CPTED theory and its components, the natural and mechanical dimensions and indicators. The other part of the chapter focuses on the development of the conceptual framework to develop a model to examine the effectiveness of the natural and mechanical dimensions and indicators of CPTED on house break-in prevention. The chapter comprises of introduction, explanations of the components of crime, definitions of CPTED, natural and mechanical CPTED, theoretical framework and underpinning the study, CPTED frameworks, common dimensions of CPTED, the review of the existing knowledge on nine dimensions and twenty-one indicators of CPTED, the definition and literature on house break-in to commit burglary, model buildings and hypotheses, and ends with a conclusion.

Chapter Three starts with an introduction and research design. It consists of two parts. The first part focuses on identifying the hotspots of house break-ins in Penang Island to locate a suitable study area for the present study. It comprises of study context and the characteristics that it must possess, the process of identifying the hotspots of house break-ins including mapping the house break-in incidences in Geographic Information System, the spatial analysis tools for identifying hotspots, and the results of the hotspot analysis using Getis-Ord and average nearest neighbour analysis, and the conclusion for the first part. The second part provides the sampling procedure by explaining the sampling frame, the calculation of minimum sample size

using WarpPLS and rule of ten, data collection procedure, the survey instrument development for measuring the natural and mechanical CPTED, instruments including the question and observation items, the pilot study consisting of convergent validity of the measurement model and content validity, the techniques for analysing the data, and the conclusion.

Chapter Four includes the results and analysis of the data. Starts with an introduction followed up by the explanations on the assessment of the measurement model and the structural model using PLS-SEM. It explains how the process of the analysis of data in WarpPLS software. Moreover, it presents the results and analysis of these assessments responding to the objectives and research questions. Chapter Five discusses the results regarding the literature. It presents the findings in response to the objectives and questions of research and discusses their alignment to the existing knowledge. The last chapter, Chapter Six provides the summary of the research background, a summary of the research findings, highlights the contribution, and ends with recommendations for future studies.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter provides the brief literature on the basic elements of a crime. It explains the development of the concept of crime prevention through environmental design (CPTED) and defines its respective dimensions and indicators. Moreover, the available literature on the five natural dimensions, namely natural surveillance, natural access control, natural territoriality, social territoriality, and natural maintenance are reviewed. Similarly, the literature on mechanical surveillance, mechanical access control, mechanical territoriality, and mechanical maintenance was utilised to conceptualise and operationalise the mechanical dimensions. Besides, the literature related to the twenty-one natural and mechanical indicators which form the nine dimensions of CPTED are discussed. This chapter then describes the development of a theoretical framework that underpins the study, and the process of selecting the common dimensions of CPTED and combining them in a single model are explained. The hypothetical model for measuring the separate and combined effects of the natural and mechanical dimensions and indicators of CPTED are presented in this chapter.

## 2.2 Dimensions of Crime

For every crime to take place, three components, namely the presence of offender/s with the motivation to commit a crime, the absence of a capable guardian and existence of a suitable target are necessary (Chainy & Ratcliffe, 2005). These essential ingredients formulate the chemistry for crime when they meet in an

appropriate time and space (Felson, 1998). Figure 2.1 presents the illustration of the 'crime triangle' by Zelinka & Brennan (2001). According to Grabosky (1995), the most promising way to achieve a sustainable residential burglary reduction is to develop strategies that can address the risk factors of target, location and offenders simultaneously. However, the elimination of each of these dimensions could prevent the incidence of crime.


Figure 2.1 Crime triangle or the basic elements of crime and the two key decisions involved in offense.

Source: (Zelinka & Brennan, 2001)

Brantingham and Brantingham (1981) introduced four dimensions of crime, namely, legal, offender, target/victim and spatial dimension which explain that for each offence to occur a target with a geographical location in a specific time must be victimised against the law. The crime dimensions are graphically represented in the form of a square except for the time dimension. Hence, a new line has been added to the square of crime as the time dimension. In Figure 2.2 the triangle of crime by Zelinka (2001), the square of crime by Brantingham and Brantingham (1981), and

the guardian (who cares for target), manager (who cares for the location), and handler (who has influence on offender) dimensions by Chainy and Ratcliffe (2005) are combined. The focus of the present study is on the target dimension which is the attributes of the house and its immediate environment.

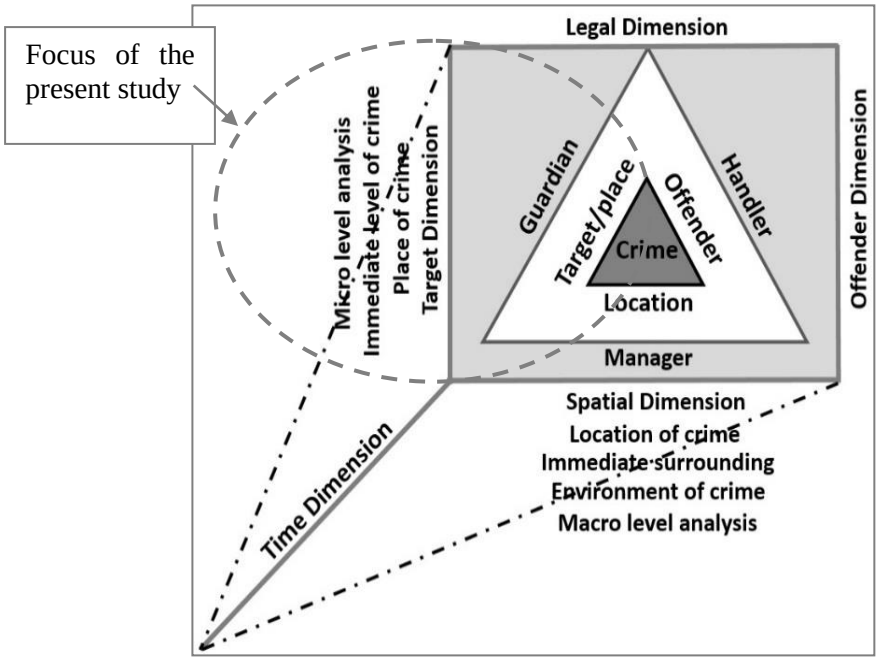


Figure 2.2 Combination of the dimensions of crime

## 2.3 Crime Prevention through Environmental Design

Brantingham & Brantingham (1981) posited that changing the physical environment (the attributes of the target) could prevent crime. Similarly, Crowe (2000) noted that the manipulation of the physical environment results in behavioural changes that reduce crime and fear of crime. For instance, the design of the physical environment affects the ability of the residents to have control over the space that they inhabit which prevents house break-ins (Abdullah, 2006). In fact, the decision of the motivated burglars to enter a specific house is largely based on the environmental cues sent by the physical attribute of the house demonstrating it as an easy or

difficult target. According to Armitage (2013) and Gibson and Johnson (2013) the most commonly cited and commonly used formal definition of CPTED is by Crowe (2000) who stated that the proper design and effective use of the built environment can lead to a reduction in the fear and incidence of crime, and an improvement in quality of life. Initially, CPTED was laid based on the idea that it is possible to use the built form to reduce the opportunities for crime (Cozens & Love, 2015). However, CPTED aims to reduce crime not only through manipulating the environment but also by altering the way individuals view them (Armitage, 2013).

Furthermore, CPTED is a complex theory that depends on the natural and mechanical dimensions or the attributes of the built environment to battle crime (Cozens et al., 2005; Kitchen & Schneider, 2007). A fair portion of the theory draws on the architectural, mechanical cues sent by the living areas to the legitimate users to take control and to the illegitimate users to discourage them from carrying a felony. Thus, an updated explanation of CPTED must consider all the aspects of CPTED and not only the built environment design. A well put together definition of CPTED is given by the International Association of CPTED (2018) referring to the theory as a multidisciplinary approach which relies upon the natural and mechanical ability of the built environment to influence offender's decisions to commit a crime.

### 2.3.1 Natural and Mechanical CPTED

Natural dimensions of CPTED are closely related to the architectural design of the house elements. They are based on the traditional argument that there is a relationship between the design features of the house and the level of break-ins (crime) by Wood (1961), Jacobs (1961), Newman (1973), and Jeffery (1971). Crowe (2000) emphasised the use of natural CPTED or the normal and natural uses of the

environment to accomplish house break-in prevention. Crowe (1991) was one of the first few researchers to talk about the mechanical dimensions versus the natural dimensions of CPTED.

According to natural CPTED, the architectural elements which are designed based on the design concepts of this theory can prevent house break-ins. The physical aspects of the house contribute to the natural dimensions of CPTED such as windows providing natural surveillance, boundary walls controlling the access to the house naturally, landscape elements giving spatial definition to the house conveying territoriality, and well-designed landscape which requires lower maintenance. On the contrary, the mechanical dimensions of CPTED involve the use of hardware and technology systems such as locks, security screens, key control systems, access control systems, and closed-circuit television (CCTV) (Atlas, 2008). Cozens (2014) and some other researchers categorised mechanical dimensions under the 'target hardening' concept. Mechanical CPTED is also referred to as 'physical security' by Armitage (2013) and 'burglary security devices' by Tseloni et al. (2017) and 'security measures' in various other research.

Regardless of CPTED being majorly developed from the architectural perspective (Cozens & Love, 2015) which forms the concept of natural CPTED, it also depends on the mechanical dimensions to provide security (Kitchen & Schneider, 2007). Armitage (2013) in her book entitle "crime prevention through housing design," included the mechanical security such as door and window locks and the installation of CCTV or burglar alarms to respectively increase perceived effort and perceived risks in potential offenders. She repeatedly cited Clark (1992) for introducing such devices for house break-in prevention and believed that

mechanical dimensions have always been a part of CPTED practices and need to be considered as the main elements of CPTED. There are some confusion and competition within the CPTED itself that boils down to one group that casually blend the natural and mechanical dimensions as opposed to another group of specialists whose emphasis is on natural approaches. The former is more of crime control model whereas the latter may be conceived as a planning model (Crowe, 2000). However, mechanical dimensions are included in the latest dynamic integrated model of CPTED by Cozens (2014). Therefore, despite the disagreement of a small group of crime prevention practitioners, mechanical dimensions are a part of CPTED and need to be tested alongside the natural dimensions (Cozens & Love, 2015).

Numerous studies show that natural dimensions work well while many thinks otherwise (Felson & Boba, 2010). The actual purpose of the modern crime prevention is to use natural measures to replace the costly methods and enhance safety intelligently. Felson and Boba (2010) referred to the use of mechanical installations such as locks, walls and thick barriers as widespread ignorance of not knowing how to implement the natural dimensions. On the other hand, researchers such as Raynald (2011) believe that the current CPTED has evolved beyond the four concepts of surveillance, access control, territoriality, and maintenance and now include the natural and mechanical dimensions due to the practical experience and development of the theory in the recent years. All the above arguments in the literature lead to the conclusion that research must yet confirm the effectiveness of mechanical CPTED on house break-in prevention (Tseloni et al., 2017). Such an investigation is complete if the efficacy of natural and mechanical CPTED are measured and compared for house break-in prevention in a single context. Therefore, the present study examines the effectiveness of both the natural and mechanical