

Systematic Literature Review (SLR) on Crime Prevention Through Environmental Design (CPTED) in Residential Areas

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Article history

Received:
15 Nov 2021

Received in revised
form:
12 Jan 2022

Accepted:
28 Feb 2022

Published online:
20 May 2022

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Abstract

Environmental design in residential areas addresses environmental traits of residential areas when developing plans or blueprints to build spaces that will benefit the natural, social, cultural and physical environment of residential areas. However, criminal threats that could be occurring from any corner of the environment could affect the tranquillity of the residents of any housing area. Although there is a second-generation CPTED model which covers most of the vulnerabilities of a premise, the study did not highlight are most essential elements of CPTED that needed to be prioritized, that can be applied to residential areas. This paper aims to review the most problematic element based on the Crime Prevention through Environmental Design (CPTED) model in residential areas. There are 13 articles selected after going through three rounds of the filtering process. Overall, there are five notable elements found from the review, the elements include Geographical Juxtaposition, Surveillance, Access Control, Territoriality and Target Hardening.

Keywords: CPTED, environmental design, crime prevention, residential areas, access control, perimeter protection

1. Introduction

Environmental design in residential areas addresses environmental traits of residential areas when developing plans or blueprints to build spaces that will benefit the natural, social, cultural and physical environment of residential areas [1]. A safe living environment is everybody's dream to enjoy a peaceful life. However, criminal threats that could be occurring from any corner of the environment could affect the tranquillity of the residents of any housing area. This issue brings the existence of CPTED architecture to ensure that any areas including housing, business, recreation and other areas are designed according to a well-thought CPTED plan.

Crime Prevention Through Environmental Design also known by its acronym CPTED where it involves the implementation of varied physical elements designed to eliminate opportunities for criminal behaviour [2]. Example of criminal behaviour is theft, robbery, kidnapping, assault, and many more.

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Although there is a second generation CPTED model which covers most of the vulnerabilities of a premise [5], the study does not highlight are most essential elements of CPTED that needed to be prioritized, that can be applied to residential areas. The purpose of this paper is to examine and highlight the most common physical security issues relating to the CPTED model. To do this, the Crime Prevention Through Environment Design (CPTED) model is used to determine the common issues based on the elements of CPTED. This paper aims to review the findings and solutions found by researchers that researched CPTED and highlight the notable issues based on the elements of CPTED via Systematic Literature Review (SLR). This paper contains five sections; section one explains the introduction of the research. Section two explains briefly the CPTED model. Section three explains the steps taken to perform the systematic literature review. Section four comprises a research matrix of the selected articles for review and a pie chart that visualizes the most affected CPTED elements addressed in the reviewed articles. This section discusses the general topics of the findings from SLR about the most affected CPTED element. Finally, section five summarises the findings of this paper.

2. Crime Prevention Through Environmental Design (CPTED) Model

Design and CPTED principles have been used for a long time, and CPTED style security measures may be dated back to the first human settlements. The construction of iron-age forts and castles, which employed walls, landscaping, moats, and drawbridges to limit access, is one example [3]. In general, CPTED is a holistic approach to criminal behaviour deterrence that focuses on modifying how places are planned out, as well as how they appear and feel. According to CPTED, changing the design of space may influence how people behave in it. The objective is to lower crime and insecurity while also raising the quality of life. For instance, CPTED's basic principle is natural surveillance, which refers to lights, windows, fences, and landscaping as measures to limit criminal opportunities in relatively cost-effective ways [4]. The issues found in the review will be categorized based on the elements of the second-generation CPTED model [5] where the ideas of CPTED extends beyond the physical and environmental design to include the community and social events happening within the residential complex [6], as shown in Figure 1

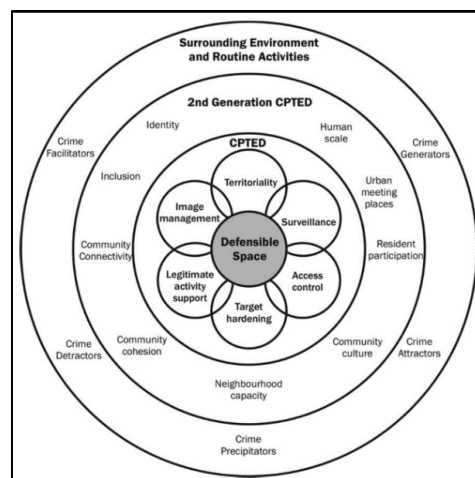


Figure 1. Second generation CPTED model [5]

3. Methodology

This section explains the methodology of the SLR performed to review the related articles about CPTED. The following subsections explain the steps taken for this SLR. The steps are based on a book titled "Producing a Systematic Review" [7].

3.1. Question Formulation

The main review question (RQ) for this study is *'What are the common physical security issues relating to the CPTED model in residential areas?'*. The literature review was performed via electronic databases with the search strings as follows:

Table 1. The list of search strings used to search for relevant papers and articles

ID.	Search Strings
SS1	(CPTED OR ("Access Control" AND "Perimeter Protection")) AND apartment
SS2	CPTED OR ("Access Control" AND "Perimeter Protection")
SS3	CPTED AND "Residential Areas" OR "Residential Area"

The search strings were created to cover most of the issues and solutions even though the keywords are different, as long the search key revolves around CPTED, access controls and perimeter protection. The key "Apartment" was included after the AND to include any CPTED solutions that can be implemented within the scope. The search string was short because there is not a lot of articles posted about CPTED. Therefore, the short search string could search a variety of articles that could be somewhat related to CPTED implementations.

3.2. Locating Studies

The systematic literature review (SLR) focuses on databases that include research papers, journals, and conferences that provide appropriate content relevant to this study. Reports that are too technical are omitted. Those reports are mainly about applied research, which involves proposing technical solutions with too much jargon that ordinary readers cannot digest the proposed approach. The materials should be published from 2010 to 2020. Three research identified databases are used as the data source: ProQuest, Science Direct Journal, and Scopus.

- ProQuest (<https://www.proquest.com/>)
- Science Direct Journal (<https://www.sciencedirect.com/>)
- Scopus (<https://www.scopus.com/home.uri>)

3.3. Study Selection and Evaluation

The criteria for study selection were: (i) the study was focused mainly on CPTED issues; (ii) the issues should involve in the security of residential areas; (iii) the article must be written in the English language; (iv) the articles and papers should be peer-reviewed; (v) the solutions proposed should involve neighbourhood planning. Physical security issues in urban areas are acceptable, as long as the issues

can also be found in residential areas because there are not a lot of articles related to residential area issues according to CPTED; (vi) no duplicates.

In the beginning, the search returned 544 resources. Table 2 shows the number of articles after going through three filter processes. N1 represents the initial number of articles returned. N2 represents the number of articles and papers after filtering out articles from the years before 2010. N3 represents the number of articles after filtering out articles outside of the search topic and the articles which are not peer-reviewed, specifically in ProQuest. Lastly, N4 represents the number of selected articles after reading through their abstract, introduction and conclusion

After refining the search, in the databases, 22 articles were chosen. Using Mendeley reference manager, the titles and abstracts were reviewed again, and the introduction was also studied. Finally, 13 resources were chosen, which is used for this SLR. Table 2 tabulates the number of papers refined while Figure 2 shows the selection process for the inclusion of the review resources.

Table 2. Paper selection Process

Database	N1	N2	N3	N4
ProQuest	385	85	9	6
ScienceDirect	97	16	4	2
Scopus	62	21	9	5
TOTAL	544	122	22	13

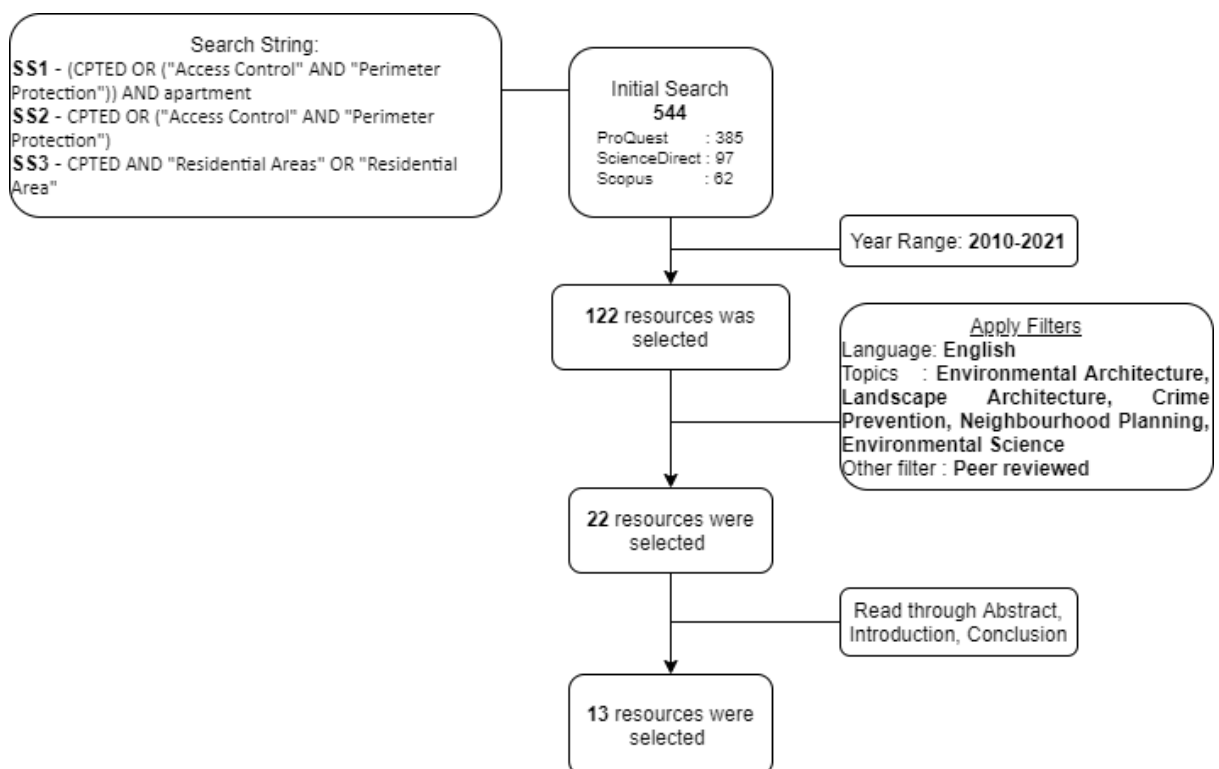


Figure 2. The SLR selection process for this study

3.4. Analysis and Synthesis

A research matrix was developed to compare the contents of the 13 articles on the criteria which are their motivation of the research, outcomes of research, and limitations during research, and their future research plan. The articles were compared using Nvivo Plus software, which is a useful tool to drag and drop the contents to classify them based on the criteria. The research matrix is then exported to a spreadsheet file, to organise and paraphrase the contents. After the contents are organized, the table is then reviewed again to extract the similar topics discussed within the 13 articles. Finally, a research matrix checklist is made. The rows of the research matrix represent the authors in alphabetical order, while the columns represent the topics discussed.

3.5. Reporting

After the articles are reviewed the results are tabulated into a research matrix. The addressed CPTED issues are categorized according to the elements in the first generation CPTED and second-generation CPTED. A checklist table is made while a pie chart is made to visualize the commonly discussed CPTED elements among the articles and the findings are discussed under section 4.

4. Results and Discussion

This section shows the results in a research matrix form where the findings were grouped according to the elements of the first generation CPTED: territoriality, surveillance, access control, target hardening, legitimate activity support, image management, and geographical juxtaposition and the second generation CPTED which includes the extra layer which is called the social layer that signifies the community activities in residential areas. The SLR was conducted to solve the research question: What are the common physical security issues in residential areas?

4.1. SLR Results

This section includes the research matrix that was made to compare the contents of the reviewed articles based on their common CPTED issues found. Table 3 shows the research matrix checklist of the topics of 13 articles, and Figure 3 shows the pie chart which shows what is the most common security issue is being discussed among the 13 papers.

Table 3. Research Matrix Checklist about the Issues in CPTED

Paper ID	Authors	Year	Territoriality	Surveillance	Access Control	Target Hardening	Legitimate Activity Support	Geographical Juxtaposition	2 nd -generation Social Layer
PID01	Qiu, Lingyi; Zhu, Xuemei [8]	2021					✓	✓	
PID02	Leccese, Francesco; Lista, Davide; Salvadori, Giacomo; Beccali, Marco; Bonomolo, Marina [9]	2020		✓					
PID03	Silva, Patrik; Li, Lin [10]	2020	✓	✓	✓			✓	
PID04	Cho, Younjoo; Jeong, Hwajin; Choi, Anseop; Sung, Minki [11]	2019		✓					
PID05	Sakip, Siti Rasidah Md; Mustafa, Anith Nabilah [12]	2019		✓	✓			✓	
PID06	Matijosaitiene, Irina; McDowald, Anthony; Juneja, Vishal [13]	2019				✓		✓	
PID07	Seifi, M.; Abdullah, A.; Haron, S.; Salman, A.; Seifi, M. [14]	2019	✓	✓	✓				
PID08	Wang, Keqi; Chen, Xiaodong; Liu, Lu [15]	2019		✓	✓			✓	
PID09	He, Li; Páez, Antonio; Liu, Desheng [16]	2017	✓			✓		✓	
PID10	Peeters, M P; Vander Beken, T [17]	2017			✓			✓	

PID11	Yoo, Chisun; Lee, Sugie [18]	2016							✓
PID12	Sugino, Hiroaki; Arima, Takafumi [19]	2014		✓				✓	
PID13	Welsh, Brandon C.; Mudge, Mark E.; Farrington, David P. [20]	2010		✓		✓			

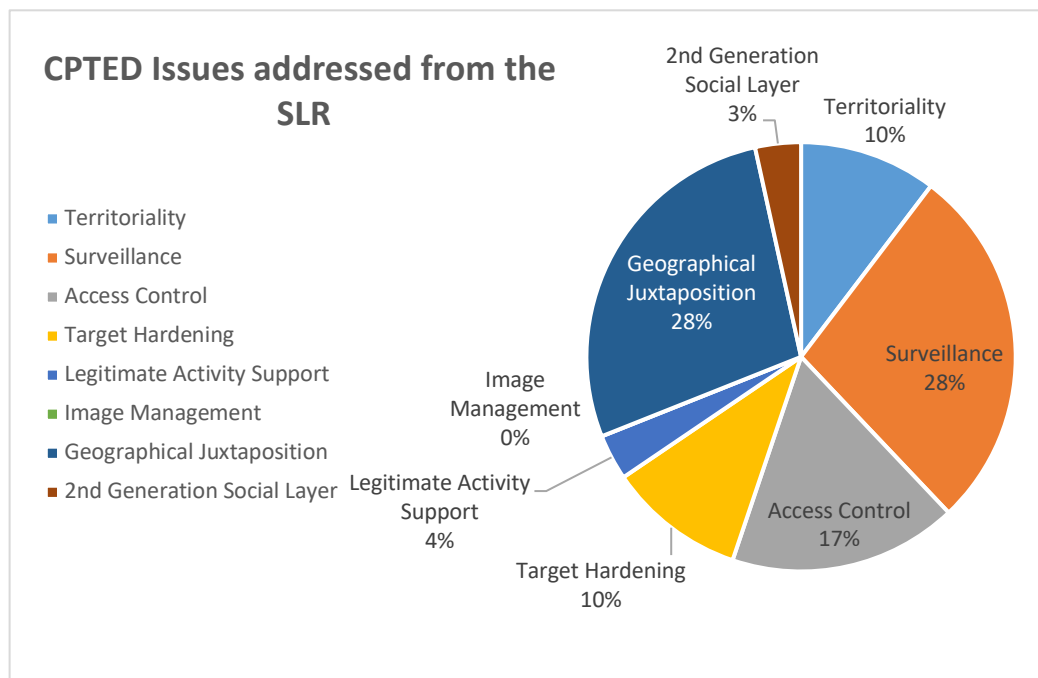


Figure 3. CPTED Issues [5], addressed from the SLR

4.2. Discussion

According to Figure 3, the most notable issues addressed in the SLR are Geographical Juxtaposition and Surveillance tied at 28 per cent, Access control at 17 per cent, and Territoriality and Target hardening tied at 10 per cent. Therefore in the discussion, the five most notable CPTED issues are discussed in this section.

4.2.1. Geographical Juxtaposition: The issue that is discussed in the reviewed papers is that there are areas within the neighbourhood or the residential areas that are risky to go to because their location attracts more crimes. Some of the respondents in the papers would take precautionary measures to not let their family or themselves go to those suspicious areas. All of the residential areas that were researched within those papers were cities and urban areas. For instance, paper PID01 [8] studied children independent mobility around the neighbourhood and found out that parents do not mind their children travelling by themselves to their relatives' or friends' houses as long they are within the neighbourhood. However, most of the parents would not let their children travel to other places alone to places like the neighbourhood centre, recreation centre and sporting field even though they

are within the neighbourhood area due to the "stranger danger" mindset. The residential area that was researched was an urban area, which is why the parents would not let their children travel there. One unique crime other than burglary addressed by other papers that addressed this issue, arson was discussed by the authors in the paper PID12 [19], discussed a case study: CPTED spatial vulnerability targeting arson. The authors found the factors that contribute to the arson crimes in the hotspot city Haruyoshi in Fukuoka, Japan for arson. Firstly, the spot is located far away from arterial roads. Secondly, the spot is surrounded by multiple buildings with various purposes. Lastly, the spot has void spaces or blind spots which allows the arsonist to sneak away from the crime scene.

4.2.2. Surveillance: The issues about surveillance, specifically natural surveillance, vary from street lighting issues, legibility and formal surveillance. The papers PID02 [9] and PID04 [11] address street lighting to be the contributing factor of natural surveillance. The authors explained that nighttime is the most vulnerable time where crimes can take place and increases the fear of crimes among pedestrians. Furthermore, the street lights usually do not have the right illuminance which makes them dim during that time. This is why street lights should have the right level of illuminance to expand the visibility of pedestrians while walking around the urban areas at night. Fortunately, the authors from PID04 [11] propose the Connected Security Lighting System (CSLS) that detects pedestrians and increases the illuminance of the street lights the pedestrians pass by, which makes the pedestrians feel safe and saves electrical energy powering the street lights. The next issue is the legibility issue, where the complex street patterns of the urban or residential areas contribute to more crimes. The authors from PID03 [10], PID05 [12] and PID08 [15] analyses the street patterns in their research area to justify that the complex street patterns can contribute to high crime rates. The corners of the streets can act as a blindspot where the adversaries can hide from the pedestrians and ambush them to perform crimes like burglary or sexual assault. The other papers discuss the formal surveillance issues. Formal surveillance involves patrolling measures that survey the area for any suspicious activities. Security guards are one of the examples of formal surveillance measures. However, with urbanization, it is challenging for the security guards to cover the whole area, especially if the area has high-rise buildings with more than ten floors. Only CCTVs can be installed in those areas, but when there are more CCTVs, the security guards in the control room have a hard time focusing on which CCTV to focus on

4.2.3. Access Control: High accessibility means when there are multiple methods of entering the area of interest. The issues addressed by the papers under this element are escapability and accessible networks. Escapability involves having many accessible gates or doors to allow the adversaries to escape from the crime scene. The paper PID03 [10] discusses that when an area can be accessible by multiple methods, the adversaries can use the same methods accessing the area to escape which makes their crime task successful. Accessible networks refer to how accessible the area of interest to multiple routes or streets. The authors from PID05 [12], PID07 [14], PID08 [15] and PID10 [17], explains that when an area is surrounded by multiple streets, the adversaries can access the area from multiple paths from different locations. Furthermore, if the area is located near to

transportation hub like a Light Rail Transit (LRT), there will be more potential adversaries from different cities who can easily access the area of interest.

4.2.4. Territoriality: There are issues when the residents do not feel a sense of ownership in their residential area. The three papers stated that having territoriality contradicts the other elements of CPTED. The authors in PID03 [10] stated that the thugs around the area of research abuse the element by socializing with the locals of the area of interest. In CPTED, it is essential to know most of the residents in the same community to feel safe with one another. Thus promoting their sense of ownership. Therefore, this social interaction contradicts the second-generation CPTED where the social layer is included [5]. The authors in PID07 [14] stated the element of territoriality contradicts with specifically two elements which are surveillance and accessibility. The point of having territoriality is for the residents to have tranquillity in their homes. However, with access gates in every corner and CCTVs everywhere for surveillance, the residents would tend to be more anxious about their privacy and safety. The authors in PID09 [16] stated a similar point where territoriality contradicts surveillance. For instance, having high fences can instil a sense of ownership in the residents. However, those fences could block the CCTVs from surveying the area where the fences are fixed [21].

4.2.5. Target Hardening: Target hardening involves implementing measures that can act as obstacles or barricades to deter adversaries [5]. The authors in PID06 [13] researched the thefts that happened in their area of interest, especially motor vehicles theft in urban areas. The lack of defensible mechanisms installed in parking spaces of the area opened up opportunities for adversaries to steal the vehicles. The authors in PID09 [16] explained the importance of target hardening which gives a sense of pride and confidence to the users to defend their homes. Lastly, PID13 [20] revealed that the implemented defensible spaces could backfire the objectives of target hardening by giving a false sense of full safety to the residents.

5. Summary and Conclusion

Overall, the CPTED model comprises various elements to protect every angle of any premise, especially residential areas. In summary, there were 13 articles chosen after going through three rounds of the filtering process. In the end, the results are tabulated into a research matrix where the field is based on the elements of the CPTED. The five most discussed elements of CPTED are geographical juxtaposition, surveillance, access control, territoriality and target hardening.

There is a limitation present during the research process, which is mainly the fact that there are limited articles regarding CPTED implementation in residential areas. This is why some of the reviewed articles relate mainly to cities and public areas, but the solutions can still be implemented in residential areas to ensure enhanced security of the well-being of the residents.

Lastly, to further this research, more time needs to be invested to look for more articles relating to CPTED journals or papers, directed to residential areas to improve the accuracy of the scope for this research. Furthermore, time will also be invested to distribute surveys to the locals of the chosen residential areas, to get a clear picture of the CPTED implementation in residential areas of Malaysia. Then

a CPTED model can be developed exclusively for the Malaysian environment for the CPTED researchers and urban planners to view it as a reference.

Acknowledgement

This review has been conducted using the facilities and the database provided by Universiti Teknologi Malaysia (UTM).

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