Systematic Literature Review Crime Prevention Through Environmental Design (CPTED) in Physical Security for IT Organization

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Abstract

Crime Prevention Through Environmental Design (CPTED) is a widely used approach to physical security and architectural design. Over the years, urban areas continue to evolve and the population in cities grows. When developing a security strategy, whether for an existing building or new construction, it is important to know the common security threats and vulnerabilities and how to address the different types of security threats. However, physical security is always neglected as most organizations focus on technology oriented security measures. Therefore, this study is aim to use crime prevention through environmental (CPTED) framework to assess the physical security by using systematic literature review (SLR) as the qualitative research method. The study also aims to explain the gaps when implementing physical security and access control in the organization. Based on the identified physical security gap, the finding from the research will recommend guidelines and solutions in implementing and improving the physical security and access control model.

Keywords: *Crime Prevention Through Environmental Design, CPTED, Physical security, perimeter protection, information technology*

1. Introduction

Crime Prevention Through Environmental Design (CPTED) is a collection of design guidelines used to fight crime, improve building protection, and promote physical security. The ideas provide theguidelines for structures and buildings that shouldbe built to withstand weather conditions andnatural disasters and also prevent crime (Cozens & Love, 2015) (Id et al., 2021). Physical security is meant to protect hardware, software, networks, data, and even human lives from serious damage if security mechanisms are not properly planned and managed. This includes natural disasters such as fires and floods, as well as burglaries, theft, vandalism, and terrorism (Hutter, 2016).

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The importance of physical security in businessescannot be underestimated. Its main goal is to protect the company's assets and infrastructure. When it comes to information security, it is important to keep in mind the defense and protection of the company from physical threats. However, physical security is always overlooked asmost companies focus on security technology, but firewalls and digital security would be useless if someone could break into the company and steal sensitive information (Hutter, 2016).

While CPTED is primarily used in the design of new buildings or new urban areas, it can also be used inthe remodeling of existing buildings or landscapes within the budget and time frame. So the organization has reasons to protect the building from criminal attacks to protect the organization's assets and information, and also the security of the employees must be ensured as part of the physical security of the organization (Gill et al., 2019)(Hussin. N, 2014).

2. Methodology

The systematic literature review (SLR) is using Kitchenham approach (Kitchenham, 2007) . The benefits of the method are that it offers understandings of a research problem and enables a study to gather the available information from a wide range of sources of (Kitchenham, 2007). The review process involved three stages; planning, conducting and reporting, as described by of (Kitchenham, 2007). Figure2-1 outlines the three phases with the steps to be performed in each phase of the SLR.

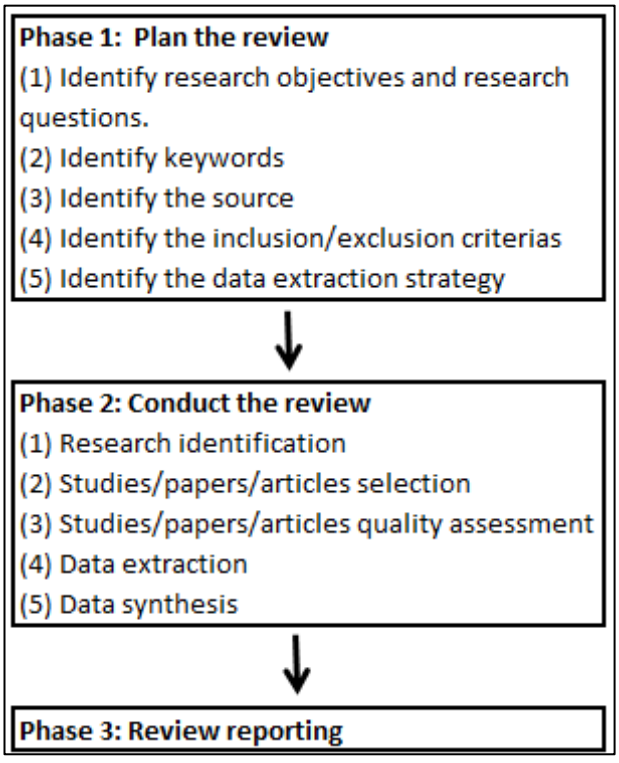

Figure 0-1 (Kitchenham, 2007)

2.1 Plan the review

In the planning phase, the research questions, keywords, resources to be searched and the inclusion and exclusion criteria are identified.

2.1.1 Identify research objectives and research questions

The objective of the SLR in this study is to identify the physical security issues in the IT Organization using CPTED principles. Therefore, the SLR formulates the following research question:

What are the physical security issues in IT Organization?

2.1.2 Identify keywords

Based on the above research question stated, the key words are CPTED, physical security, Information Technology. Some of the keywords are further derived to similar meaning of as below:-

i. Physical security - > perimeter protection
ii. Information Technology -> Information System
iii. CPTED -> CPTED principle, CPTED designs, CPTED approaches, CPTED policy

After the search keywords are identified, they were compiled into a search string to be used in the source searching process. In this paper, the operator "AND" is used to link with different keywords search into the search string. The operator "OR" is used to group various synonyms or similar spellings of the search keywords. Thus the formulated keyword searches are as below:-

("physical security" OR "perimeter protection" OR "security management") AND ("Information Technology" OR "Information system") AND ("CPTED" OR "CPTED principle" OR "CPTED approaches" OR "CPTED designs" OR "CPTED policy")

2.1.3 Identify the source

The following online academic databases are identified as the research resources:-

i. Emerald Insight
ii. Science Direct
iii. Scopus
iv. Google Scholar

2.1.4 Identify the inclusion/exclusion criteria

The below are the inclusion and exclusion for all the searched paper based on the below criteria:-
Inclusion:

i. Any journal papers, studies with the above defined search keywords.
ii. Any journal papers, studies written and published in English language.
iii. Full text writing journal paper.

Exclusion:

i. Any journal papers, studies without the above defined search keywords.
ii. Any journal papers, studies not written and published in English language.
iii. Not Full text writing journal paper.
iv. Repeated journal papers and studies.

2.1.5 Identify the data extraction strategy

Data extraction will be based on below compilation:-

i. ID
ii. Title
iii. Year
iv. Author
v. Journal/Publisher
vi. Publication Type

2.2 Conduct the review

After the review planning stage has been done and finalized, the paper review process will be started in phase 2 which include research identification, research selection, assessing the paper quality, data extraction and synthesis.

2.2.1 Research identification

Based on the identifying search keyword, studies searching via online academic databases (Table2-1).

Table 2-1 Result from academic database

Source	**Result**
Emerald Insight	44
Science Direct	81
Scopus	350
Google Scholar	268
Total	743

2.2.2 Studies/Papers/Articles selection and assessment

The search process was not restricted during the research study. A collection of inclusion and exclusion criteria were used to narrow down the number of studies that were considered and defined in Table 2.1
Initially, each retrieved paper was selected by reading the title, abstract, and keywords, and studies that did not meet the inclusion/exclusion criteria were omitted. Where the title and abstract of a paper did not include enough detail to make a decision, the full text was consulted, and the decision was made using the inclusion/exclusion criteria.

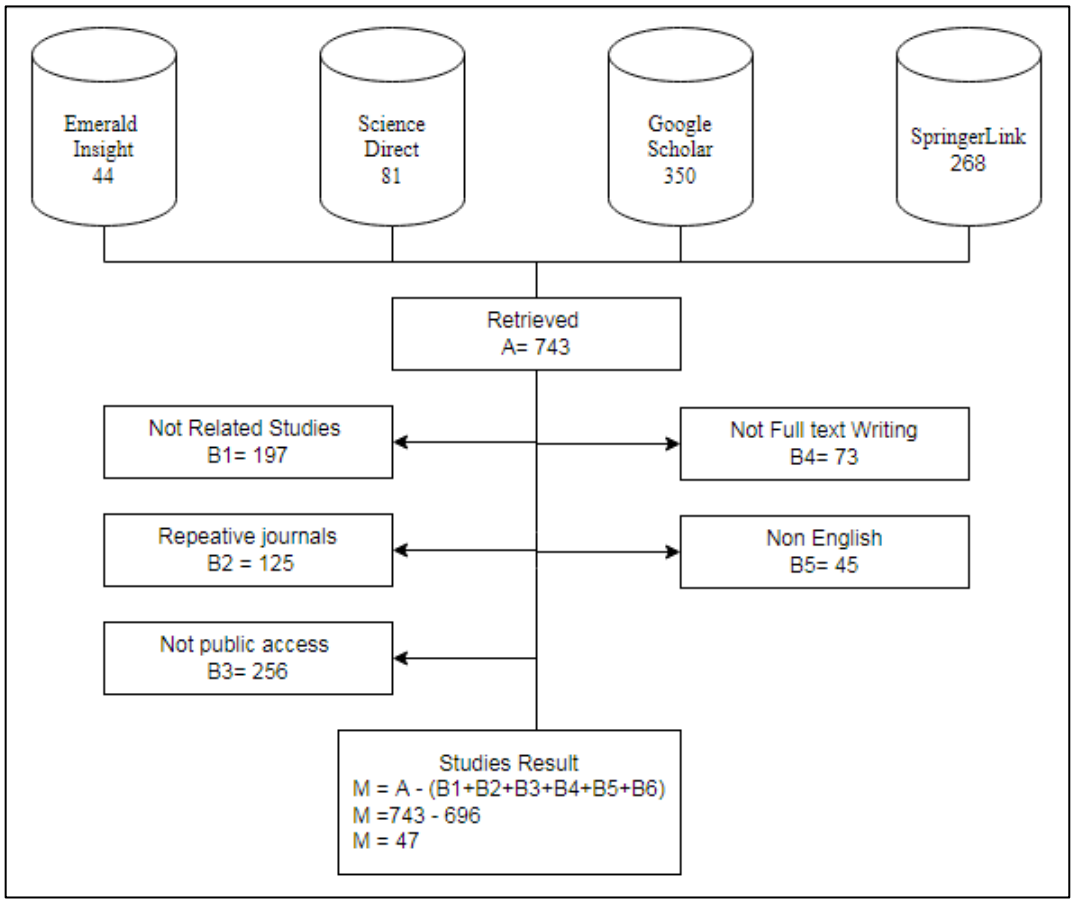

Figure 0-2 Result of Studies searching

2.2.3 Studies/Papers/Articles quality assessment

Kitchenham, 2007 proposed a consistency checklist for this SLR. This article focuses on biasing and validity problems that arise during different stages of scientific research.

Table 2-2 Assessment question

No	Question
Q1	Is the study/journal objectives clearly defined?
Q2	Is the study/journal described clearly?
Q3	Is there a variety of views and circumstances explored in the study?
Q4	Do the objectives related to conclusions clearly?
Q5	Are the findings important?
Q6	Do the researchers go through the implications of any challenges?
Q7	Does the study value added to knowledge?

2.2.4 Data extraction

The total number of studies retrieved was specified in below after the assessment procedure, and the folders were named after the source database/search engine from which the study was downloaded in Mendeley. All studies were listed, along with their authors and publication year. For reference on the data extraction method, each of the primary studies included was given a unique identification number (i.e. ID). An ID was applied to the file name if there were several publications in the same year. Following the first author's completion of the data extraction process, the second author to cross-check the extracted data. The extracted data shown as below table (Table2-3)

Table 0-3 Extracted studies

ID	Title	Year	Author	Journal/Publisher	Publication Type
A01	Malaysian Public Sector Management Of Information & Communications Technology Security Handbook	2001	Mampu	Perpustakaan Negara Malaysia	Book
A02	A manual for crime prevention through planning and design	2001	Kruger, T., Landman, K., & Liebermann, S.	Council for Scientific and Industrial Research (CSIR)	Book
A03	An overview of the current level of Security Awareness in Greek companies	2011	Papagiannaki s, K	Erasmus University of Rotterdam	Thesis

A04	Crime prevention through environmental design	2012	Cozens, P.M., Saville, G., Hillier, D.	Journal of Property Management	Journal Article
A05	American Transactions on Engineering & Applied Sciences Safe City Concept and Crime Prevention Through Environmental Design (CPTED) for Urban Sustainability in Malaysian Cities.	2013	Shamsuddin, S. B.	American Transactions on Engineering & Applied Sciences	Journal Article
A06	21st century security and CPTED: Designing for critical infrastructure protection and crime prevention, second edition	2013	Atlas, R. I	In CRC Press.	Book
A07	A Review and Current Status of Crime Prevention through Environmental Design (CPTED)	2015	Cozens, P., & Love, T.	Journal of Planning Literature,	Journal Article
A08	Improving Safety in a Historic Downtown Area of Winnipeg Through Infrastructure Renewal	2015	Richard Tebinka, Scott Suderman, K. R.	2015 Conference of the Transportation Association of Canada Charlottetown	Conference Proceedings
A09	Physical Security and Why It Is Important	2016	Hutter, D	SANS Institute Information Security Reading Room.	Report
A10	Identifying and Preventing Insider Threats.	2016	Matthew D. Waters	Eastern Kentucky University	Thesis
A11	Awareness by Kuala Lumpur City Hall staffs for successful implementation of crime prevention through environmental design (CPTED)	2016	Shuhana, S., & Natasha Azim, H.	Journal of the Malaysian Institute of Planners	Journal Article

A12	Effect of crime prevention through environmental design (CPTED) measures on active living and fear of crime.	2016	Lee, J. S., Park, S., & Jung, S.	MDPI Sustainability	Journal Article
A13	The Dark Side of Crime Prevention Through Environmental Design (CPTED)	2017	Cozens, P., & Love, T.	Oxford Research Encyclopedia of Criminology and Criminal Justice	Journal Article
A14	Information Security Landscape in Supply Chain	2017	N.Safa, C.Maple, T. W.	The Warwick Research Archive Portal (WRAP) Makes	Journal Article
A15	A human factors contribution to countering insider threats	2017	Hills, M., & Anjali, A.	Security Journal,	Journal Article
A16	Information Security Reading Room Physical Security and Why It Is Important	2019	Hutter, D	SANS Institute Information Security Reading Room.	Report
A17	Crime Prevention Through Environmental Design: A Review on Potential Improvement in its Concept for a Safer City	2019	Rozhan, A., & Mohd Yunus, M. Y. (2019)	International Journal of Engineering & Technology,	Journal Article
A18	Mobile Security: Threats and Best Practices	2020	Weichbroth, P., & Łysik, Ł.	Hindawi Mobile Information Systems	Journal Article
A19	Physical security problems in local governments: A survey	2020	Phin, P. A., Abbas, H., & Kamaruddin, N	Journal of Environmental Treatment Techniques	Journal Article
A20	Protection of Transport Terminals through the Application of the CPTED Concept.	2021	Králová, K., Šoltés, V., & Kotalová, N.	Transportation Research Procedia	Journal Article

2.2.5 Data synthesis and Finding

After the above steps, there are 20 selected studies for this SLR. This include 12 journals articles, 2 reports, 3 books, 1 conference paper and 2 for master and phd

student's thesis papers. Most of the studies are journal articles which have contributed 60% of the total studies papers (Figure 2-3).

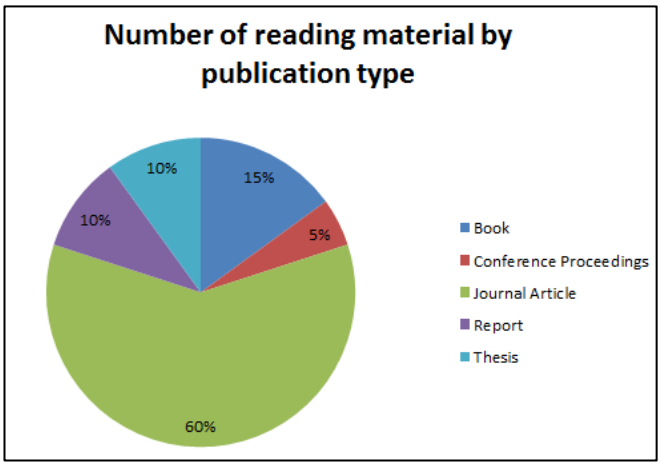

Figure 0-3 Reading material based on publication type

2.3 Review Reporting

There are numbers of existing journal articles which have been discussed on based on the research objective defined earlier.

Table 0-4 Literature Review topic

Literature Review topic	**ID**
Physical Security issues in IT Organization	A01, A03, A09, A10, A16, A18, A19
CPTED principles in Physical Security	A02, A04, A05, A06, A07, A08, A11 A12, A13, A16, A17, A20
Factors to be considered when implementing CPTED in Physical Security	A01, A05, A08, A14, A15

3. Discussion

3.1 Physical Security issues in IT Organization

The importance of physical security in a business cannot be underestimated. Its main objective is to protect the company's assets and infrastructure. When it comes to information security, it is important to defend and protect the company from physical threats. However, physical security is always overlooked as most companies focus on security technology, but firewalls and digital security would be useless if someone could break into the company and steal sensitive information. (Papagiannakis, 2011).

3.2 CPTED principles in Physical Security

Crime Prevention Through Environmental Design, also known as CPTED, is a collection of design guidelines used to prevent crime, improve building protection, and promote physical security. The idea is to provide guidelines to structures and buildings that should be built to withstand weather and natural disasters and also serve to prevent crime (Hutter, 2019).While CPTED is primarily used in the design of new buildings or new urban areas, it can also be used for retrofitting existing buildings or landscaping, depending on budget and schedule (Králová et al., 2021).

The emergence of urban area has indirectly led to a high risk of criminal activity (Cozens & Love, 2015). CPTED is commonly used in residential, industrial and commercial areas such as recreational parks, residential areas, office buildings and many more. Thus, the organization has reasons to secure the premises from criminal attacks to protect the assets and information of the organization. Apart from protecting the assets, the security of the employees also needs to be ensured as part of the physical security of the organization.

CPTED principles focus on recognising the cognitive processes of a potential criminal and creating an environment that minimises prosecution. Employees and tenants benefit from CPTED because it creates a sense of security and well-being for them (Richard Tebinka, Scott Suderman, 2015). When CPTED is implemented, the subsequent landscape that encompasses the building and its surroundings can prevent or deter illegal activity while encouraging individuals to keep a close eye on assets on the premises.

Compared to other advanced industrialized countries, CPTED concepts are popular and widely used in Europe, America, Australia, and Asia (Cozens & Love, 2015)(Cozens & Love, 2017). However, the implementation of CPTED in Malaysia is still in its initial stage as some implementers and local authorities are not yet aware of CPTED concepts (Shamsuddin, 2013) (Rozhan & Mohd Yunus, 2019). To achieve successful and effective CPTED implementation, both implementers and local authorities should have a higher level of awareness and understanding of CPTED concepts (Shuhana & Natasha Azim, 2016). Therefore, collaboration between the organization, organization staff, and CPTED implementers plays an important role in achieving the goal of physical security through the adoption of CPTED concepts during the CPTED planning, design, and implementation phases (Shuhana & Natasha Azim, 2016).

3.2.1 Natural Surveillance

Natural surveillance is the idea of placing "eyes on the street" that make the place undesirable for criminal activity (Steventon, 2012). Good surveillance allows people to see what others are doing and prevents criminals from committing crimes in the monitored location. The effectiveness of surveillance can be either natural or mechanical and internal or external. Thus, the possibility of natural surveillance is determined by the design of the street, landscaping and lighting and mechanical

surveillance can be in the form of CCTV, security guards, security fences and many more.

3.2.2 Natural Access control

Access control under CPTED is about limiting the possibility of unauthorised persons entering premises where they are not permitted to enter, thereby posing a risk to others. Control provides a 'sense of direction' and directs the flow of access in and out of the building, making it visible who is coming and going. It is important that a building does not have too many entry points. By reducing the number of entrances, you can prevent unauthorised people from being where they should not be. Physical and symbolic barriers can be used to attract, channel or restrict the movement of people, reducing opportunities for criminals (Lee et al., 2016).

3.2.3 Territorial reinforcement

This principle promotes social control to ensure that employees have a sense of control over the area in which they feel comfortable. It promotes a sense of ownership because employees who own the space are more likely to respond to potential crimes or risks in or near the space by reporting them quickly or trying to avoid them (Atlas, 2013). According to the principle of territorial reinforcement, physical design can create or extend a boundary of private or semi-private space that alerts intruders to territorial influence. Therefore, this concept clearly defines the transitions and boundaries between public and private areas of the structures or buildings.

3.2.4 Management and Maintenance

A well-maintained public space attracts employees and becomes a popular meeting place, which is related to the principle of territorial reinforcement that ensures that the space is properly used and maintained (Lee et al., 2016). By establishing minimum requirements and quality standards, proper maintenance protects public health, safety, and welfare in all existing structures and spaces, whether residential or commercial. Maintenance and management must be considered at the design stage, as the materials and finishes chosen will have an impact on the type of maintenance that can be maintained over time (Kruger et al., 2001).

3.3 Factors to be considered when implementing CPTED in Physical Security

CPTED has the ability to significantly reduce crime and make communities safer. However, it should be emphasised that CPTED implementation sometimes targets only certain forms of crime in certain metropolitan areas. Crime prevention methods that work well in one setting may not work as well in another. It is therefore important to develop solutions to crime problems based on a thorough understanding of the local environment, including the criminal scenario and the physical, social and institutional context.

3.3.1 Understand and prioritization risk of safety and security aspects

Many companies place a high priority on maintaining a safe and healthy workplace (Richard Tebinka, Scott Suderman, 2015). Identify vulnerable locations and consider improvements to ensure adequate protection. It is most successfully managed when community safety is continuously considered throughout the planning and design phases of a new development (Shamsuddin, 2013). Crime problems, on the other hand, are common in well-established sites and locations, so a review is needed to identify site-specific problems and make recommendations for improvements. When safety procedures and standards are followed correctly and everyone works together to limit risk, workplace accidents are drastically reduced. These include views of the site from adjacent properties or the property line, as well as possible views of parking lots and buildings, views from one section of the site to another, and views of parking lots, walkways, and other elements of the site from various positions within the building. These design components must be supported by potential observers, as well as regulations and processes, such as those related to landscape maintenance, to ensure individual and organizational safety (Mampu, 2001).

3.3.2 Cost of implementation and maintenance

Theoretically, the more expensive a security system is, the more secure it is. Consequently, when setting up a physical security system for a site, companies need to compare the business risks (or potential costs) with the cost of the physical security system (Mampu, 2001)(N.Safa, C.Maple, 2017). As a business expands its capabilities, physical security components may be added. For example, initially the company may rely only on simple door locks and not employ a security guard. As the business expands into a more complicated structure, on-site security guards or optical sensors can be added, while more modern security solutions such as advanced CCTV systems can be used for security surveillance and biometric scanning for access control. In addition, the company will consider the choice of materials and types of maintenance that will endure over time while constructing CPTED in a more cost-effective manner. For example, different types of lighting should be used in different locations to ensure safety, and plant species should be selected so that they do not obstruct the line of sight when they are fully grown.

3.3.3 Regulatory Reinforcement

Based on CPTED principles, there are a variety of standard guidelines and regulatory requirements that address, for example, the design of physical accessibility, lighting, and signage for built environments based on CPTED guidelines (Hutter, 2019). Developers and anyone seriously concerned with the design of the built environment need to incorporate CPTED principles into their considerations (Rajadurai, 2021). Development in the urban environment is usually controlled by separate developments. With the principle defined in CPTED, master

planning should be considered at the beginning of a development, which is easier in cases where one developer is doing most of the development. When a group of developers is involved and urban areas are growing and changing, it is usually the responsibility of local supervisors and the local government to ensure that CPTED principles are incorporated into the management of the development, which needs to be aligned with existing suburbs (Hills & Anjali, 2017). It is also important that property owners support CPTED over time by making appropriate changes or retrofitting existing properties. In addition, a similar level of detail is required in other areas such as signage and barrier-free access, as well as the preparation of complete detailed plans. Landscape architects must incorporate the body of CPTED concepts into requirements based on specific detailed local regulatory or advisory documents.

4. Limitations

The research is based on the selected journals, books sections, students thesis to identify the literature review topics in various aspect. These aspects were evaluated based on the selected studies which the coverage is limited based on individual knowledge and assumption. Besides there are possibilities that the review was done with misunderstanding and lack of accuracy as there are numerous of studies in the digital libraries in the recent years in the related research.

5. Conclusion

Physical security must be ingrained in the culture of every organization, regardless large or small size of the company in any industry. The security measures taken can have a significant impact on the safety of employees and the success of the company. However, companies sometimes overlook and underestimate the importance of physical security in favor of cyber security. There are reasons why physical security is concerned with protecting sensitive data, confidential information, networks, software, equipment, facilities, company assets, and human lives. There are elements that can impact security such as natural disasters like floods, fires, and power outages that are the first to exploit assets, are difficult to recover from, and can lead to irreversible data loss. Moreover, attacks from attackers such as terrorism, vandalism, and theft can be another factor that affects the physical security threats and affects the organizations in different ways. The study highlights the importance of natural surveillance, access control, territorial reinforcement, and maintenance as the key CPTED principles that cannot be overlooked in creating a sense of security. Furthermore, when implementing CPTED principles, it is not enough to focus only on physical environmental design. Management and staff support and leadership must also provide adequate assistance in the form of sound crime prevention through environmental design guideline.

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