CPTED Assessment in High Rise Building Underground Parking Facilities (Case Study: Cambridge City Square)

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Abstract. Buildings grow rapidly in urban areas. Along with the newly built buildings, the need for supporting facilities is increased significantly like the need for parking facilities. Yet, there was still a failure on the building design that will lead criminals to do something that can be dangerous and threaten human security. However, there is still anther ways to prevent crime by considering the design and criminal aspects, that is CPTED (Crime Prevention Through Environmental Design). This research aims to assess CPTED implementation in a high rise building underground parking facilities in Medan. This research uses the descriptive qualitative method to reveal data systematically, factually, and describe the various phenomenon of a particular population or area. Data stored and processed with AHP (Analytical Hierarchy Process) methods with the help of computer software named Super Decision on getting the value of each specific CPTED key concept for parking facilities. The final CPTED assessment score is 2.994 out of 4. This score is on the range of 2,51-3,00 rating system and categorized as good and shows that CPTED implementation at Cambridge City Square underground parking facilities is suited in CPTED principles even though there are still various components of variables and sub-variables were missing and below standard quality. The result of this research is expected to be useful in the field of architecture especially in preventing crime.

Keyword: ahp, cpted, parking

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1 Introduction

Buildings grow rapidly in urban areas because the increasing of economic growth, the increasing population of residents who occupy the city, and the need for a new space to carry out human activities from economic, socio-cultural, recreational, educational, health to residential activities.

Along with those newly built buildings, the need for supporting facilities is increased significantly like the need for parking facilities. Yet, there was still a failure on the building

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design that will lead criminals to do something that can be dangerous and threaten human security. However, there is still another way to prevent crime by considering the design and criminal aspects, that is CPTED (Crime Prevention Through Environmental Design). This method is an architectural solution considered as simple and less popular. There are still "weaknesses" in architectural design considered by the author so that the need to assess the CPTED implementation in a high rise building underground parking area. This research aims to assess CPTED implementation in a high rise building underground parking facilities in Medan.

2 Literature Review

C. Ray Jeffery first used the phrase "crime prevention through environmental design", but Jane Jacobs's 1961 classic, The Death and Life of Great American Cities, deeply influenced the CPTED idea [1]. CPTED is based on the argument which states that most crime incidents are supported by opportunities created by the design of their physical environment **[2]**. According to Marzbali et. al, Crime Prevention Through Environmental Design or commonly called CPTED, is an effective and appropriate design of the built environment that aims to reduce the fear and incidence of crime [3]. This involves the design and management of the built environment to reduce the opportunities for crime and deviant behaviour. CPTED promotes active, mixed-use developments and works best when active community participation is recruited [4]. CPTED uses a more natural approach with environmental changes to reduce crime in a positive manner [5][6]. CPTED is now considered one of the most advanced and effective methods, in some cases, in preventing crime within the living spaces [7]. Countries throughout the world, such as Australia, Canada, and European countries have used architectural design techniques to prevent crime [8][9].

CPTED is a specialized field of study focusing on *[10]*: (1) Physical environments. The physical environment can be manipulated to produce behavioural effects that will reduce fear and the incidence of certain types of criminal activity; (2) The behaviour of people about their physical environment. Some locations seem to create, promote, or allow criminal activity, incivilities, or unruly behaviour, whereas other environments elicit compliant and law-abiding conduct; (3) Redesigning or use existing space more effectively to encourage desirable behaviours and discourage crime and related undesirable conduct. It is through the insight and frame-work of CPTED, which serves to develop and ensure a better-designed and used environment.

Moffat in *[2]* states that CPTED focuses on six key concepts: territoriality; surveillance; image management; activity support; access control; target hardening (Figure 1).

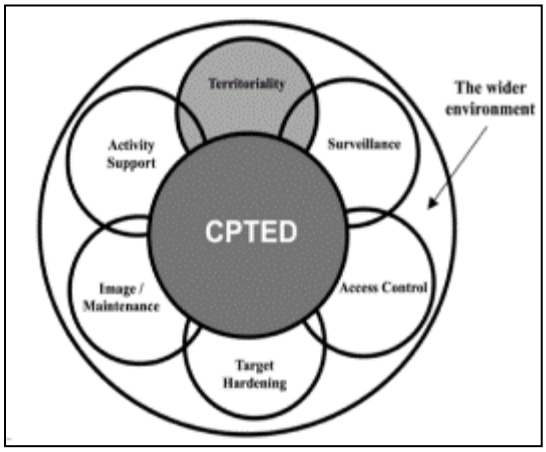

Figure 1 CPTED Key Concept

Parking plays an important role in urban transport systems [11]. Many parking facilities do not have a CPTED design features because most property owners and architects are not familiar with the basic principles of design concepts for crime prevention [12]. Parking facilities comprise a large volume of space with relatively low levels of activity; violent crime is more likely to occur in a parking facility than in other commercial facilities [12]. The conceptual thrust of the CPTED programs that the physical environment can be manipulated to produce behavioural effects that will reduce the incidence and fear of crime, thereby improving the quality of life [1].

There are seven specific CPTED key concepts for parking facilities: perimeter control; landscaping and access point; CCTV and surveillance; graphics and wayfinding; lighting; mixed and multiple uses; security management [10]. Those seven specific key concepts for parking facilities are the specific concepts coming from six key concepts of CPTED.

3 Method

This research uses the descriptive qualitative method. The purpose of using a qualitative descriptive method is to reveal data systematically, factually, and describe the various phenomenon of a particular population or area [13].

Research variables using seven specific CPTED key concepts for parking facilities (Table 1) by Atlas [10]. Data stored and processed with AHP (Analytical Hierarchy Process) methods with the help of computer software named Super Decision on getting the value of each specific CPTED key concept for parking facilities. The Analytic Hierarchy Process (AHP) is a problem-solving framework, and it organizes the basic rationality by breaking down a problem into its smaller constituent parts and then calls for only simple pairwise comparison judgments, to develop priorities in each hierarchy [14].

Table 1 Variables

Variable	Sub-Variable
Perimeter Control	Territoriality reinforcement
Landscaping and Access Point	Location and amount of vehicle access Location and amount of pedestrian access
CCTV and Surveillance	Mechanical security features Visibility in parking facilities Elevators and stairwells
Graphics and Wayfinding	Graphics and wayfinding position Graphics and wayfinding quality
Lighting	Light intensity
Mixed and Multiple Uses	Location and type ofactivity support
Security Management	Physical maintenance Location of the security office Entry-exit parking system

After obtaining the value of each specific CPTED key concepts for parking facilities then author assesses the presence of each CPTED key concept in parking facilities features in Cambridge City Square underground parking facilities from 1 to 4 (1 CPTED features not available; 2 CPTED features partially available although below standard; 3 CPTED features fully available although below standard; 4 CPTED features fully available and according to the standard). Each variable was assessed and the results multiplied with the value of CPTED key concepts for parking facilities to get the final score of each variable. Then the addition of each variable's final score is the final CPTED assessment in Cambridge City Square underground parking facilities. The final CPTED assessment score is categorized in 1-4 rating systems (1,00-1,50 very poor; 1,51-2,00 poor; 2,01-2,50 fair; 2,51-3,00 good; 3,01-3,50 very good; 3,51-4,00 excellent).

4 Result and Analysis

Perimeter Control

Between loading dock and parking area, there is a low railing as a barrier between the public and private zone. There is also standing signage in front of Cambridge City Square management office as a barrier between public and private zone. There is also an adjustable parking pole shown in Figure 2 so vehicles cant park in the prohibited area. Vehicles who park in the prohibited area could lower the visibility in the parking facilities.

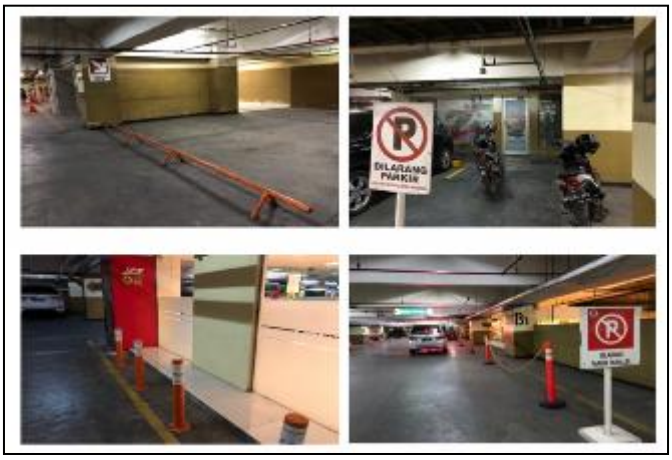

Figure 2 Territoriality reinforcement

Landscape and Access Point

As shown in Figure 3 & 4, vehicle entry and entry and exit points are separated. The entry point is on the west of the building while the exit point is in the south of the building. The less of vehicle access, it's easier to monitoring and controlling who is accessing the building.

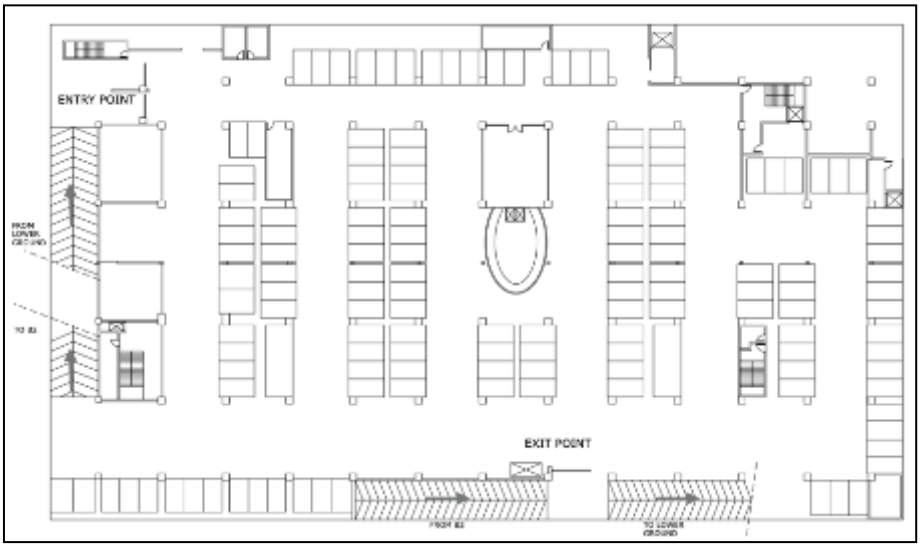

Figure 3 Vehicle Access Point

Figure 4 Vehicle Access

There are four different kinds of pedestrian access to/from parking facilities as shown in Figure 5 & 6: (1) mall access point; (2) hotel access point; (3) apartment access point; (4) emergency stairs. The most commonly used access by the shopkeeper, security, cleaning service is emergency stairs. Whilst mall or hotel visitor use mall or hotel access point and barely use emergency stairs. There are 3 emergency stairs located differently and frequently used and being a potential hiding place for criminals. With too much access to the parking facilities, it will reduce the ability to control who can enter the parking facilities on foot.

Figure 5 Pedestrian Access Point

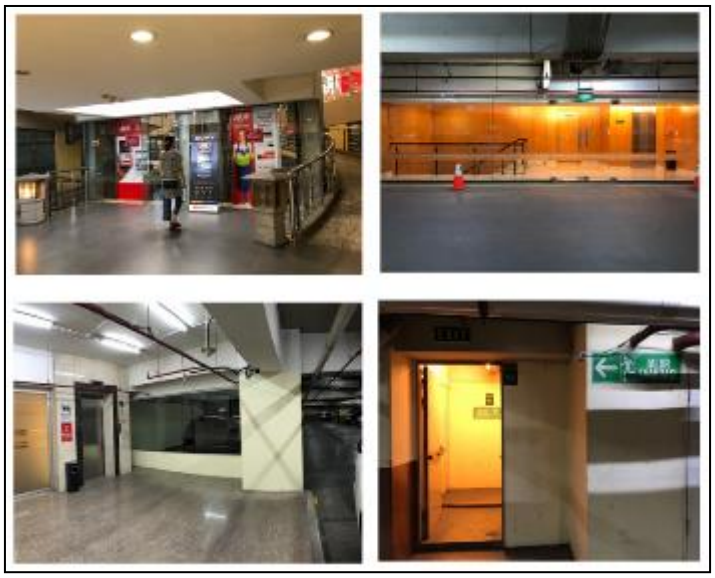

Figure 6 Pedestrian Access

CCTV and Surveillance

As shown in Figure 7, there is CCTV as mechanical security features in parking facilities. All CCTV's covered all parking facilities from potential crime occur like behind structural column, vehicle entry portals, emergency stairs, elevator, etc. but there is no presence of panic button and intercom in parking facilities.

Figure 7 CCTV

As shown in Figure 8 & 9, there is a huge size of the structural column in parking facilities and behind the column is a management room in the middle of parking facilities. This will reduce visibility and can be used by criminals.

Figure 8 Visibility

Figure 9 Visibility

There are too many management rooms in the middle of parking facilities and will lower the visibility. As shown in Figure 10, there is also a brick wall as a room divider between the mall loading dock and the parking facilities that also can lower the visibility in parking facilities. Using solid material as a room divider can make potential hiding places for criminals.

Figure 10 Visibility

The hotel access point, shown in Figure 11 using glass materials as a room divider. Using glass as a room divider will increase visibility in parking facilities because stairs are often used as a potential hiding place for criminals. The mall access point, shown in Figure 12, also uses glass materials to enhance visibility in the parking area. Mall elevators using glass materials and spiral ramp as a vertical circulation so it can enhance visibility. Also shown in Figure 13, the apartment access point using glass as a room divider.

Figure 11 Elevator and Stairwells

Figure 12 Elevator and Stairwells

Figure 13 Elevator and stairwells

Graphics and Wayfinding

Most of the signage position is overhead signage. Signage positioning can easily be tracked by eye and guiding users in parking facilities. There is also floor signage, as shown in Figure 14 in parking facilities.

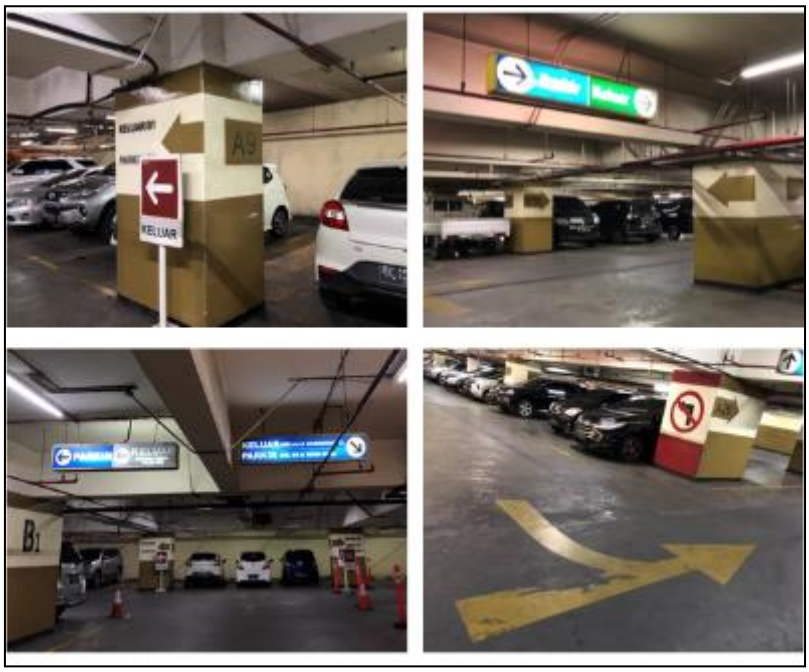

Figure 14 Graphics and Wayfinding

Signage can easily read. Most of the signage is the neon box, shown in Figure 15, most of the signage got extra lighting. Signage is having a precise dimension and base colour of the signage using prominent colour. Signage in Figure 16, giving territoriality and show where is walkway and vehicle way. Also, every story has different colour and font theme as a territorial reinforcement.

Figure 15 Graphics and Wayfinding

Figure 16 Graphics and Wayfinding

Lighting

Lighting is considered the most important security feature in parking facilities [12]. Both IESNA (Illuminating Engineering Society of North America) and NPA (National Parking Association) sets what is generally considered the minimum standard for lighting design in parking facilities (Table 2). Based on the author's analysis using digital lux meter in parking facilities, there are only 2 out of 5 categories that meet the minimum standard for lighting design in parking facilities those are General Parking Area and Mall access.

Table 2 Analysis Result

	NPA Footcandle	IESNA Footcandle	Analysis Result		
General parking area	6 fc	5 fc	7.2 fc (78 lux)		
Ramps and corners	-	10 fc	Entry ramp 5.2 fc (56 lux)		Exit ramp 8.2 fc (89 lux)
Vehicle entrance	40 fc	50 fc	15.1 fc (163 lux)		
Vehicle exit	20 fc	-	7.7 fc (83 lux)		
Stairwells, exit lobbies	20 fc	15 fc	Apartment access 11.7 fc (126 lux)	Mall access 15.7 fc (170 lux)	Hotel access 7.8 fc (84 lux)

Mixed and Multiple Uses

Overall there are three different activity support that enhances surveillance in parking facilities. The first is Musholla, shown in Figure 17, located in Basement 3 next to the motorcycle park. The presence of Musholla increases significant 'surveillance' provided by Musholla users. There is also a seating area in the centre of parking facilities, shown in Figure 18that are often used by chauffeur and security. In mall access, there are commercial activities that sell goods and services (Figure 19). This kind of activity increases parking facilities' level of activity and directly increase surveillance.

Figure 17 Musholla

Figure 18 Seating Area

Figure 19 Commercial

Security Management

Cambridge City Square underground parking facilities well-maintained by cleaning services. Signage and all electronic devices such as lighting work fine. No litter was found on parking facilities (Figure 20).

Figure 20 Physical Maintenance

Security office located in Basement 2 on the east side of the building (Figure 21). There is vertical circulation near the security office to facilitate security movement, so they easily moved from one story to another.

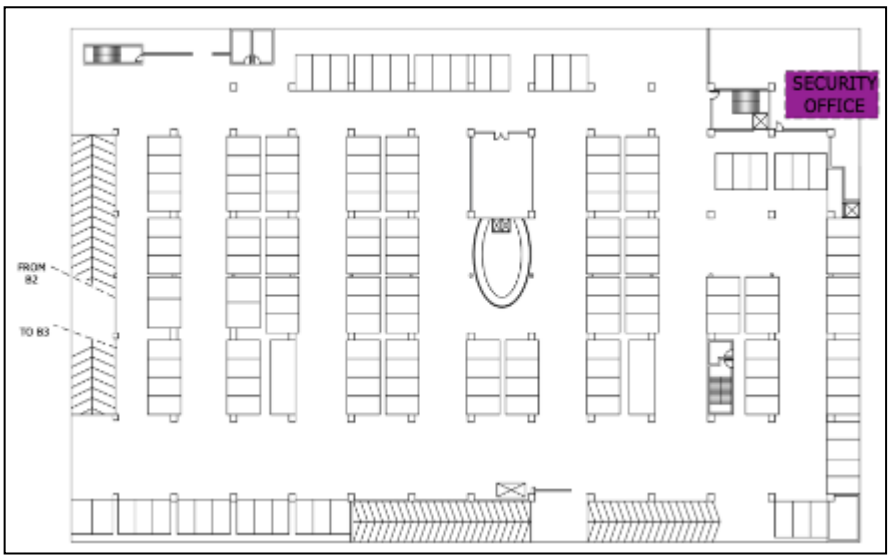

Figure 21 Security Office

Entry-exit parking system scheme is as shown in Figure 22; the first step is the vehicle being checked by security to prevent drivers from bringing dangerous goods such as a weapon. The second step is taking the parking ticket on the ticket machine as proof of vehicle entry. The last step is parking ticket validity and parking payment at the exit booth.

Figure 22 Entry-exit Parking System Scheme

CPTED Assessment Score

The following is the recapitulation of CPTED assessment in the Cambridge City Square underground parking facilities which the author has previously analyzed, and each of the variables and sub-variablesvalue have been determined by the Super Decision software.

Based on Table 3, it can be concluded that the application of CPTED in the Cambridge City Square underground parking facilities is in accordance with the CPTED principle because the total assessment score is 2.994.

Table 3 CPTED Assessment Score

Variables	Sub-Variables	Value	CPTED score	Total
Perimeter Control	Territoriallity reinforcement	0.103	3	0.309
Landscape and Access Point	Location and amount of vehicle access	0.036	4	0.144
	Location and amount of pedestrian access	0.036	3	0.108
CCTV and Surveillance	Mechanical security features	0.101	3	0.303
	Visibility in parking facilities	0.063	2	0.126
	Elevators and stairwells	0.040	4	0.160
Graphics and Wayfinding	Graphics and wayfinding position	0.49	4	0.196
	Graphics and wayfinding quality	0.49	4	0.196
Lighting	Light intensity	0.304	2	0.608
Mixed and Multiple Uses	Location and type ofactivity support	0.047	4	0.188
Security Management	Physical maintenance	0.041	4	0.164
	Location of the security office	0.041	4	0.164
	Entry-exit parking system	0.082	4	0.328
			TOTAL	**2.994**

5 Conclusion

The final CPTED assessment score is 2.994 out of 4. This score is on the range of 2,51-3,00 rating system and categorized as good and shows that CPTED implementation at Cambridge City Square underground parking facilities is suited in CPTED principles even though there are still various components of variables and sub-variables were missing and below standard quality.

There are 2 sub-variables that got the lowest score: visibility in parking facilities and light intensity. The author proposed design recommendation to improve these sub-variables: (1) visibility in parking facilities by relocating management rooms in the middle of parking facilities to the front or rear end parking facilities and changing loading dock room divider to wire mesh partition to enhance visibility; (2) light intensity by adding a light point to increased light intensity and using metal halide lamp. Many CPTED practitioners recommend metal halide lamp because that last until 20.000 hours and have 90 out of 100 Color Rendering Index [10].

Acknowledgement

The result of this research is expected to be useful in the field of architecture, especially in preventing crime. Upcoming research can use other methods to assess CPTED features on building to gain more precise results.

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