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Estimating the Validity of CPTED Guidelines on Residence Hall in University: Through the Comparison between CPTED Checklists and Space Syntax Analysis

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Abstract University residence halls have become one of the most important issues for students when selecting their academic institutions. However, in South Korea, while universities maintain technologically up-to-date facilities, when it comes to safety or security, the management is unsatisfactory. As a result, the number of violent crime has been increasing. However, there are few researches in terms of practical validity of CPTED Guidelines even though a myriad of researchers study about CPTED Guidelines. Therefore, this study endeavours to investigate the validity of theoretical CPTED Guidelines that to what extent it might be adopted for design process. As a methodology, Space Syntax Convex map and Visibility Graph Analysis (VGA) are chosen. As a result, since the types of space which have a high level of Space Syntax Index are analogous with space treated on CPTED Guidelines, it roughly shows that the theoretical CPTED Guidelines could be adopted in practical architectural design process. Furthermore, it reveals that there is a close relationship between detail design guide stated in CPTED Guidelines and the result of VGA. That is, through the analysis, it is proved that the validity of CPTED Guidelines is quite enough to be adopted in practical design process.

Keywords: Residence Hall, CPTED, Guidelines, Space Syntax, VGA

1. INTRODUCTION

With the increase of educational fever, universities need to develop their facilities and academic quality. In particular, university residence halls, which were only a simple residential space in 1960s, have become one of the most important issues for students when selecting their academic institutions. Currently, most residence halls include double rooms, studios and a number of amenities including a catering system, small market, computer laboratory and a library in comfortable environment compared to the past. Furthermore, universities endeavour attention to fulfil the students' requirements to attract foreign students and provide an oratory or small auditorium for students who are religious. Since the number of foreign students has increased from 12,000 in the early 2000s to 85,000 in 2013, universities can no longer remain spectators to this situation (Woo, 2015; Ministry of Education, 2014).

However, while universities maintain technologically up-to-date facilities, when it comes to safety or security, the management is unsatisfactory. Universities have not done their duty, even though students should be protected by a strong security system in the university's area. There were 269 sexual assaults in 107 universities between 2009 and 2013 (Lee, 2013). At an university in Busan, there were two sexual assaults in the residence halls in 2014 and the administrative office did not recognise the crime until the victim reported to the police. The office suffered severe criticism from the public because it only proposed general and simple preparation to prevent the recurrence of the crime (Jo, 2013).

Practically, universities struggle to satisfy students by improving the campus built environment and building new libraries or academic facilities due to the lack of funding. Therefore, they demand increased tuition fees or government subsidies, however, these might not be allowed. As a provisional measure, universities secure sufficient funds by lessening their investment in residence halls since they are not of interest to all students. Therefore, the university utilises the same countermeasures – installing CCTV and increasing the patrols – towards violent crimes. For instance, the standard output specification for a university residence hall by the Ministry of Education does not contain any technical and practical guidelines except the superficial statement that CCTV

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should be utilised (Ministry of Education, 2015)

The western countries have already experienced this problem and a myriad of researchers have realised that crime cannot be prevented by a single factor. They also recognised that the establishment of CCTV and the increase of patrols were insufficient to prevent crimes, therefore, they tried to approach crime with a universal perspective through the cooperation of criminologists, architects, psychologists and sociologists. They proposed a lot of causes for crime in terms of the social environment, including the decline of the built environment, the lack of pedestrians and vehicles, geographic issues, surrounding urban tissues and the economic status of the residences. These approaches led to the invention of Crime Prevention through Environmental Design (CPTED) and architects launched a study on properly built environmental design and effective circulation for crime prevention. The CPTED theory was adopted for diverse types of architecture, including academic facilities, and dispersed around the world.

However, in South Korea, there are no CPTED guidelines for university residence halls, even though reports related to CPTED guidelines by the government and private researchers are abundant. In addition, the guidelines do not contain any technical advice for a specific inner space based on Korean university dormitory – space configuration and the spatial hierarchy – that might be intrinsic elements for a potential crime scene. So this research estimates the validity of CPTED guideline on university residence halls.

The research will be divided into five chapters. The second chapter, literature review, will analyse the basic concepts and history of residence halls, CPTED and space syntax. In the third chapter, the methodology used to achieve the purpose of this study will be explained. The pivotal part of this study, the fourth chapter, will examine the validity of CPTED guidelines on practical design process of residence halls in seven universities in Busan analysed by the space syntax and the VGA. The final chapter will connect the purpose of the study to the analyses and conclude with some suggestions.

2. LITERATURE REVIEW

1) Residence Hall

The residence hall originated as a communal facility for adolescents who left their home to study in Ancient Athens and Sparta and it has changed significantly since that era. In fact, the residence halls in monasteries and universities in the Middle Ages were the archetype of the current residence hall. It technically became a dormitory style dwelling which was separate from the academic facilities in the United Kingdom and France in the 19th century, and became known as Public House and Lycée respectively (Ha, 2004).

In South Korea, under the building act, the residence hall is a multi-unit house that is for students or employees in academic institutions or factories. As the residence hall has both educational and residential roles, it includes a variety of space such as a kitchen, lounge, library, toilet and private rooms. In particular, it has several orientation programs that encourage students to be rounded people by obeying the rules for communal living. Therefore, residence halls must maintain a proper level of safety for their residents and act in an educational capacity (MOLIT, 2013).

Studies about residence halls are primarily based on environmental behaviour theory, which indicates that students are more easily influenced by their colleagues than any other social group since they have social similarity (Case, 1981). Since the physical environment influences the social environment, it affects personal attitude, virtues, and psychology (Moos, 1978). Therefore, it is plausible that specific characteristics of space – arrangement, connection or isolation – in residence halls physically and psychologically interacts with students (Woo, 2015).

Korean researchers have paid attention to three themes; space composition in residence halls; the residential satisfaction of students; and estimating the proper area for public and private space in residence halls. The Ministry of Education published the dormitory guideline for space planning and chronicled the approach to the residence hall. Studies on the changes to the space by different types of dormitory and the changes in spatial configuration over time have been conducted (Ha, 2004; Choi, 2012). A residence hall needs many more types of space than in the past due to the increase of foreign students. For instance, due to religious factors, a small chapel is necessary for prayer and a special kitchen for students who cannot eat certain foods. In order to obtain detailed information that which space are needed for foreign students, researchers conducted a survey to examine foreign students' consciousness of the residential environment and proposed communal dormitories that might suit the students (Ahn, Jang and Shin, 2015).

Examining the residents' satisfaction with their living environment is one of the major focuses of research about university residence halls. However, most studies focus on narrow topics, such as satisfaction with educational quality or the facilities such as the libraries and computer laboratories. While some academic reports are about residence halls, the majority of the survey respondents are Chinese and Japanese students (An, 2003; Lee, 2011). To address these shortcomings, Sodbileg divided the subject of satisfaction into three categories; residence, medical services and common lifestyle, and surveyed an equal number of foreign students (2014). Other researchers have gathered information from Korean students to use these results as basic data in the construction of new residence halls (Song and Roh, 2004).

Estimating residential area was also a popular research theme since universities traditionally prefer to increase the number of students to be accommodated in a given place. Therefore, researchers endeavoured to determine a proper area of personal unit space, common space and circulation space to maintain the residents' quality of life and the original role of the dormitory (Oh, 2008; Yang et al., 2015).

2) Crime Prevention through Environmental Design (CPTED)

In 1960s, the original concept of Crime Prevention through Environmental Design (CPTED) was developed as a set of guidelines to address security issues by Elizabeth Wood when she worked at the Chicago Housing Authority. In the one of the greatest books on social science, "the death and life of great American cities," (1961) Jane Jacobs highlighted the relationship between crime and urban design with three pivotal attributes: a clear demarcation of private and public space; diversity of use; and a high level of pedestrian use of the sidewalks.

The terminology, CPTED, was first defined by C. Ray Jeffery in the 1970s. Based on this definition, Oscar Newman and George Rand began research on the crime-environment connection. Newman, as an architect, strengthened on the built environment design. In his publication, "Defensible Space (1972)", Jeffery analysed the relationship between the built environment and crime data from New York City public housing. Newman asserts that there are two basic components in defensible space: maintaining surveillance by residents to easily observe and identify potential offenders, and encouraging residents to have a sense of ownership and security that brings about a decrease of crime through continuous neighbourhood interaction.

Newman and others made an effort to improve defensible space theory by adding CPTED based features, particularly in institutional and commercial fields. The advanced theory includes the 'broken window' theory proposed by James Wilson and George Kelling (1982), which revealed the relationship between visible deterioration and human behaviour. Some criminologists, including Ronald Clarke, Patricia Mayhew and Timothy Crowe, claimed that 'situational crime prevention,' as a method of CPTED, improved the built environment design approach to reduce the opportunity to offend (Crowe, 1991).

During the 1990s, the CPTED theory extended its influence over human society since it combined knowledge from many different disciplines. In addition to the typical external environmental crime prevention, the internal environment approach was suggested through the analysis of modern brain science (Jeffery, 1990). Under the implementation of the US Government's largest CPTED assistance and training program, Severin Sorensen and Ronald Clarke developed a new theoretical basis for situational crime prevention, which limits or reduces the chance of crime by establishing crime prevention circumstances, for CPTED measurements. The underlying assumption of situational crime prevention is rational choice theory. The researchers believed that the possibility of crime would decrease when the criminal felt that the opportunity cost of the crime was low due to the crime prevention environmental design (Becker, 1976). Furthermore, Clarke proposed 16 methods to reduce crime rates, including target hardening, access control, offender deflecting and natural surveillance (Clarke, 1997). Of these methods, five elements have become major CPTED concepts - natural surveillance, natural access control, territoriality, activity support and maintenance, and management. The CPTED theory has been accepted in diverse societies and specific fields.

A myriad of research has been conducted based on the standard CPTED theory, particularly on the placement of elevator halls and security offices. Installing these facilities creates a high level of surveillance and circumstances that can protect the site from crimes (Do et al., 1991). The relationship between the characteristics of buildings; size, the building-to-land ratio and building density, and probability of crime was also a favourite subject for many researchers. However, the results of those studies appeared to diverge according to the site location, geographic issues and the surrounding conditions (Min el al., 1992; Park, 1992; Choi, 1993). The CPTED studies on university campuses concentrated on campus libraries, parking lots or specific academic facilities. The majority of them investigated the users' fear of crime, causes of crime and to what extent CPTED theory might be adopted for the buildings on campus (Lee, Choi and Ha, 2010).

Research about CPTED guidelines has focused on case studies of foreign countries, such as the United States and United Kingdom, and proposed a Korean version of the CPTED guidelines to build a safe educational facilities through the site investigation (Ha and Lee, 2011). By analysing the legal system or CPTED guidelines for schools and campuses in developed countries with a survey targeting Korean architects and criminologists, researchers defined the elements for CPTED guidelines that were suitable for secondary schools in South Korea (Kang and Park, 2011).

Both the national or municipal government has tried to establish the relevant guidelines in diverse fields including multi-unit houses, academic institutions, urban planning and urban regeneration projects. In the United Kingdom, the Association of Chief Police Officers announced 'New Schools 2014' which provides guidelines for architectural design and building arrangement based on CPTED theory (ACPO, 2014). The Florida Centre for Community Design and Research, United States, published the Florida Safe School Design Guidelines which includes guidelines on the environment, site design, building design, interior space and systems & equipment (1993). The CPTED guidelines for New Town planning (2004) were developed by the Seoul Special City government and the other cities in South Korea have made to developing CPTED guidelines for declining urban area as a priority.

Kim and Kim (2011) criticized these diverse types of guidelines since they are only theoretical statements and they are not applicable to the real world. They asserted that the introduction of CPTED requires in-depth analysis in terms of legal and institutional shortcomings and the subject of the application, and proposes methods to address these problems. Another study developed the CPTED evaluation indicator for crime prevention according to the type of structure, such as neighbourhood parks, multi-unit houses and schools (Sohn, Kim and Kim, 2015). As there are no formal guidelines, the researchers studied those themes based on empirical an investigation through site analysis or interviews.

Although a number of studies were conducted on campus CPTED, there are no proposals or content on CPTED guidelines for university residence halls in South Korea nor a detailed analysis on how the CPTED theory be adapted for the architectural design of the residence halls. While this study appears to have a narrow focus, it would be invaluable if architects and the administrators of academic institutions has basic rules to apply that might protect students from violent crime in the dormitories.

3) Space Syntax

Space syntax theory was first developed by Bill Hillier, a professor of the Bartlett School of Architecture, in the early 1980s. He wondered why the council housing established in the 1960s and 1970s in the United Kingdom was unpopular. During the research, he recognised that the space pattern might influence a residence area and underlined the importance of understanding the differences between conventional urban tissue and the current urban pattern in order to answer that question. Therefore, he attempted to define some common features by analysing a myriad of types of urban space and the relationship among architectures, open space and the structure of street networks. He finally developed the theory of space syntax, which became a major space pattern analysis tool (Hillier and Hanson, 1984).

This theory has attracted the public's attention because structuralism in the field of social science became universal in academia in that era and the public questioned the connection between architectural space structure and social structure. As the researcher applied a linguistic principle to social anthropology, he assumed that a cellular composition of space units was a part of the organic structure, similar to how a sentence could transmit a specific meaning through the smallest unit, such as a phoneme or a word. Space syntax has become one of the most popular methodology in the field of social science.

Theoretically, researchers who study space syntax believe that a space can be analysed as a small element of society or an area, not as a single unit, due to the complexity of society. Therefore, they tried to analyse architecture or urban space based on graphs of node, edge and depth by identifying space topology. It investigates the connectivity of a group of space and attempts to quantitatively and objectively recognise the innate social characteristics. For instance, Choi and Lee (2002) argues that space which has a high rate of connectivity is supposed to be used for a range of social behaviours among the public and this brings about a low rate of violent crime. With the development of space syntax methodology, computer software might perform a more concrete analysis by calculating numerical values, such as connectivity, integration, control and intelligibility, and drawing a graph – axial map and convex map – through mathematical processes (Choi, 2008).

In order to focus the necessity of CPTED guidelines for university residence halls, the relationship between crime and space syntax is a pivotal theme for reviewing the preliminary research of the myriad of studies on space syntax. First, identifying the characteristics of the crime location through the space syntax has been implemented by many researchers. They used the 'axial map' of space syntax and calculated numerical values for the space and compared it with the crime rate of that space to determine the connection between them. While this led to several different results, the majority of the research revealed that the crime rate was inversely proportional to the integration of the space (Choi and Lee, 2002). Analyses of urban areas, such as urban street networks, urban space configurations and specific places including markets and hotels, were undertaken (Yeon, 2008). In addition to using space syntax, which focuses on theoretical analysis, the Geographic Information System, which can reflect local figures, was utilised for the spatial structure analysis (Yun, 2012).

Space syntax played a substantial role in providing scientific and logical data. Typically, a justified plan graph was developed in new town development areas. A justified plan graph is a type of diagram that symbolizes the individual interior space and shows the depth of space and the connectivity, control value or integration among entire space. Hwang (2013) analysed the space structures within houses in five new town development areas and in Bongwha, a rural area, through the graph. In conjunction with CPTED, positioning CCTV and emergency services efficiently through space syntax was proposed. As the role of those devices increased, space syntax provided professionals with most effective location to prevent crimes with the least amount of equipment and personal effort.

4) Differentiation

Most studies investigating the combination of above themes concentrated on the relationship between the crime rate and the unique floor plan of residence halls – gallery type, double-loaded corridor type and core type (Choi, 1993) – however, they could not find a connection among them. Since residence halls have a complex floor plan with diverse circulation, the past analyses are useless in a practical sense. In addition, as residence halls are a social behaviour space, they should be analysed with innate characteristics that might show the connectivity among space, major circulation and the phase to approach the destination. These elements will be exploited to prevent crimes in the real world. However, those researches do not extend smoothly to practical usage.

Therefore, this research will estimate the validity of CPTED guidelines on residence halls by verifying the relationship between the space that should be considered in CPTED theory and the space that have a high level of space syntax index in the residence halls of Korean universities. Indeed, through the VGA, the detail design guide in CPTED could be adopted directly to the visual diagram on a floor plan. As a result, these processes would be catalyst for the application of CPTED theory to actual world.

3. METHODOLOGY

As the aim of this research is to measure the impact of the theoretical CPTED guidelines on the practical architectural design based on the characteristics of the space. Therefore, the proof of that – the modelling of analogous types of space treated under the concepts of those two principles – is the most important point of this study. The methodology consists of five steps.

The basis of the study is eliciting critical space that should be in need of CPTED. The space which were described as vital spots for security in more than half of the CPTED guidelines established by foreign and domestic educational institutions and governments were summarised and prepared for analysis of the relationship with space investigated by space syntax index. Third, detailed CPTED guideline information – circulation, the number of entrances and space that should be adjacent to a certain space – will be categorised and listed according to individual space. This will facilitate an additional Visibility Graph Analysis (VGA) based on the floor plan that will have practical applications. Fourth, a convex map of the floor plans of newly-built university residence halls and university residence halls that will be constructed in Busan will be developed using space syntax and VGA software. In addition, the space will be listed based on the level of space syntax and how that result was derived. Finally, an empirical analysis will be conducted, comparing the space that were on the CPTED guidelines to space selected by space syntax analysis and the detail design guide to space analysed by VGA for measuring the validity of a technical residence hall CPTED guideline.

4. ANALYSIS

1) Defining Space through CPTED Domestic & Foreign Guidelines

This chapter will re-organise the basic space that compose a residence hall that were stated on foreign and domestic CTPED guidelines. The guidelines were chosen by popularity through the literature review and critically assessed to determine whether they

Table 4-1 Space mentioned by CPTED guidelines

CPTED		Guidelines												
Basic Components	Space or Elements	1	2	3	4	5	6	7	8	9	10	11	12	13
Natural Surveillance	Entrance	O	O	O	O	O	O	O	O	O	O	O	O	O
	Parking Lot	O		O	O	O	O		O	O	O	O	O	O
Natural Access Control	Lobby	O		O				O						O
	Security Hall	O	O	O	O	O	O		O	O	O	O	O	O
	Corridor	O		O	O			O		O		O		
	Stairs / Elevator	O		O			O	O	O	O	O	O		O
	Toilets	O		O				O						
	Administrative Office			O				O						
Territorial Reinforcement	Security System	O	O	O	O	O	O	O	O	O	O	O		O
Activity Support	Catering System			O			O		O					
	Amenity			O					O	O		O	O	

1. Crime Prevention Through Environmental Design Guidebook
2. Safe Schools Facilities Planner: Health and Life Safety School Climate and Order
3. The Appropriate and Effective Use of Security Technologies in U.S. Schools
4. Safety by Design: Creating a safer environment in Virginia
5. Residential House and Unit Complex Assessment
6. New Schools 2014
7. College and University Residence Hall Design Guidelines
8. CPTED guidelines for Architecture under the Enforcement Decree of the Building Act [ROK]
9. Seoul Special City Government CPTED guidelines for New Town planning [ROK]
10. CPTED guidelines Multifunctional Administrative City [ROK]
11. CPTED guidelines for Innovation City [ROK]
12. Seoul Special City Government CPTED guidelines [ROK]
13. How to Institutionalize CPTED in Korea by Korean Institute of Criminology [ROK]

Table 4-2 Detail information about Space

CPTED		Guidelines
Basic Components	Space or Elements	Details
Natural Surveillance	Entrance	Planning an distinctive entrance which is easily recognized Minimising the number of entrances
	Parking Lot	Planning it to distinctly recognize the visitors Placing it in front of the building to be easily monitored by security guards
Natural Access Control	Security Hall	Placing it where security guards can observe every direction of the floor
	Corridor	Planning linear corridors that directly connect to the security hall
	Stairs / Elevator	Placing it near the security hall or administrative office
Territorial Reinforcement	Security System	Surveillance on visitors by security guards or CCTV Using a door lock system such as an electronic security card

are directly related to the research topic or not.

There are 13 guidelines. In terms of foreign guidelines, the practical residence hall CPTED guidelines; Residential House and Unit Complex Assessment (2007), College and University Residence Hall Design Guidelines (2009), are being used in universities, and the other guidelines; Safe Schools Facilities Planner: Health and Life Safety School Climate and Order (1998), The Appropriate and Effective Use of Security Technologies in U.S. Schools (1999), New Schools 2014 (2014), Safety by Design: Creating a safer environment in Virginia (2005), Crime Prevention Through Environmental Design Guidebook (2003), were selected and adapted to fit Korean residence halls.

There had been no residence hall CPTED guidelines in South Korea until now. Therefore, the official CPTED guidelines for urban space that were publicised by the government – CPTED Guidelines for Architecture under the Enforcement Decree of the Building Act (2013), Seoul Special City Government CPTED guidelines for New Town planning (2009), CPTED guidelines Multifunctional Administrative City, CPTED guidelines for Innovation City (Korean Educational Development Institute, 2010) and Seoul Special City Government CPTED guidelines (2013) – were investigated to select the essential space for a residence hall CPTED. In addition to these guidelines, this research references the academic report 'How to Institutionalise CPTED in Korea (2010)' by the Korean Institute of Criminology, particularly the multi-unit house section, since residence halls are categorised as a multi-unit houses under the building act in South Korea. There are 11 important space that should be contemplated in detail to maintain safety in the residence halls when they are built. However, only six space appeared in more than half of the guidelines and were sorted for further analysis and comparisons with the space analysed by VGA.

According to the analysis, the most popular and important CPTED component is natural surveillance. In particular, the entrance hall has several check points such as the number of entrances, the type of entrance, the materials of the door and cautions for installing CCTV at the entrance hall. The parking lot is also treated as diverse ground. The major characteristics of it are the separation between the visitors and the residence, the distance between the residence hall and the parking lot, and its shape and space configuration with the surrounding buildings.

In terms of natural access control, the greatest number of space was considered. However, several guidelines have different requirements for the same space. For instance, some guidelines state that the lobby should be included for security reasons whereas the others claim that the space is not needed since it causes many people to visit as it is a public space. Most of the guidelines include the contents of security. The security hall should be positioned at the centre of the floor in order to check every space simultaneously. As the corridor acts as the main route to individual space in the residence hall, it should be designed linearly so that every activity can be monitored. The stairs or elevator hall has a number of check points under the concept of disaster prevention. The guidelines propose the proper width of stairs, finishing materials of the hall and emergency circulation. It also contains some pieces of advice about the location of CCTV in the stair hall for direct surveillance from the security hall. Since the toilet is a private space, the guidelines focus on the methodology for observing the aberrational users instead of the location. Finally, the administrative office is regarded as an extension of security hall. Therefore, the guideline advocates a prudent floor plan to easily both residents and visitors.

For Territorial Reinforcement, a door lock system with electronic security cards and monitoring CCTV in the security hall or administrative office should be required. Under this concept the most important thing is preventing unauthorised access, consequently, the access control system is underlined. In the field of activity support, establishing amenity facilities such as a fitness club and catering system is treated as a main point. The use of those facilities encourages the residents to have a sense of belonging which increases the natural surveillance level of active users.

2) Residence Hall Analysis through Space Syntax

Space syntax analysis was implemented using seven national or private university residence hall floor plans in Busan. While a convex map can show spatial hierarchy – connectivity, integration, depth and control value – with diverse graphs, this research only intends to use the control value and integration since those are proven values which are strongly correlated to the crime rate.

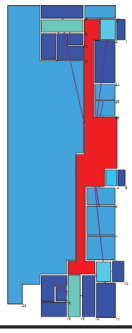
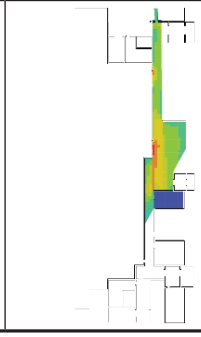
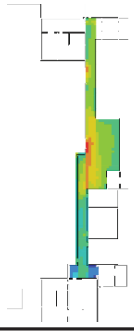
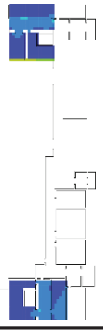
The control value shows the control level that the space has on the surrounding space. A high control value means that the space has a number of adjacent space. The greater the control value is, the lower the crime rate is. Since it is plausible that a potential criminal will be threatened by a high level of control, the criminal does not tend to commit crime. Integration is a level of the spatial hierarchy and it is closely connected to the volume of pedestrians. A low volume of pedestrian means that there is a higher possibility of crime (Choi and Lee, 2002). Therefore, the space syntax index can illustrate that the space related to the crime rate and those space should be considered in the design process.

According to the analysis, space that have a high level of control

Table 4-3 Space Syntax Index

University	Space Syntax	Ranking				
		1	2	3	4	5
A	Control Value	Corridor	Lobby	Stair	Catering	Elevator
		11.40	2.333	1.777	1.033	1.014
	Integration	Elevator	Corridor	Stair	Lobby	
		2.019	1.611	1.434	1.280	
B	Control Value	Corridor	Lobby	Security	Entrance	
		8.566	4.083	2.083	1.083	
	Integration	Corridor	Lobby	Security	Amenity	
		4.521	2.027	1.781	1.588	
C	Control Value	Lobby	Corridor	Stair	Catering	
		5.70	3.625	1.50	1.20	
	Integration	Lobby	Corridor	Stair	Elevator	Admin
		3.362	2.353	1.307	1.307	1.176
D	Control Value	Corridor	Lobby	Entrance	Security	
		16.833	3.333	1.166	1.071	
	Integration	Corridor	Elevator	Security	Entrance	Lobby
		1.669	1.481	1.411	1.309	1.156
E	Control Value	Corridor	Lobby	Admin	Stair	
		7.50	4.0	1.5	1.0	
	Integration	Corridor	Stair	Elevator	Amenity	
		1.406	1.184	1.046	0.865	
F	Control Value	Lobby	Corridor	Catering	Amenity	Stair
		10.39	6.5	4.576	2.576	1.142
	Integration	Lobby	Elevator	Catering	Stair	Amenity
		3.243	2.027	1.977	1.762	1.725
G	Control Value	Amenity	Corridor	Elevator	Stair	Lobby
		5.833	3.0	1.833	1.642	1.166
	Integration	Lobby	Entrance	Amenity	Elevator	Stair
		1.330	1.068	1.049	1.166	0.948

Table 4-4 Comparison between Convex map and VGA based on detail design guide in CPTED

Space or Elements	Details			
Entrance	Planning an distinctive entrance which is easily recognized			
Security Hall	Placing it where security guards can observe every direction of the floor			
Corridor	Planning linear corridors that directly connect to the security hall			
Stairs / Elevator	Placing it near the security hall or administrative office			
Convex map	VGA			
	Entrance	Security Hall	Corridor	Stairs / Elevator
				

and integration are the corridor, lobby, entrance, amenities, elevator hall, stair hall, security hall and catering system. A few space were added in addition to the space that were stated in major the CPTED guidelines such as amenities, the catering system and lobby.

While the catering system and amenities in the guidelines were used to encourage the students to have a sense of belonging, they have a great impact on the adjacent space in space syntax analysis due to the characteristics of Korean residence halls. The foreign residence facilities focused on their residential role and the residents were excluded from the catering systems and student welfare facilities. However, in South Korea, most university residence halls include these space in a single building to provide students with high quality lives. Consequently, such space should be located on the main floor for easy access, resulting in a high level of space syntax index (Table 3).

The lobby shows the highest level of space syntax since its main role differs from that listed in the guidelines. In the guidelines, lobby acts as a transitional space where the security guard can observe people who pass through the entrance of the residence hall whereas in the space syntax it is used for circulation to the individual and private rooms.

In other words, it is natural for the lobby to have a high level of integration and control since the lobby in South Korea connects the most of the space in the structure. This can also explain the high level of Space Syntax index of the corridor, elevator hall and stair hall. Since the main purpose of those space is connecting the other space, it is fair that those space record high Space Syntax index.

The analogous of the types of space stated on CTPED guidelines and space analysed through Space Syntax shows that there is somewhat relevant impact of CPTED guidelines when it would be adopted in practical design process. However, it is not reasonable to illustrate that there is definite positive validity of CPTED guidelines in practical design since space which have a high level of integration and control level undoubtedly have a low level of crime rate.

Also, if some other visual analyses of floor plan can prove the needs of detail design advice for six vital spots elicited from above 13 CPTED guidelines, it would be more effective to assert the validity of CPTED guidelines in practical design process in addition to the Space Syntax analysis.

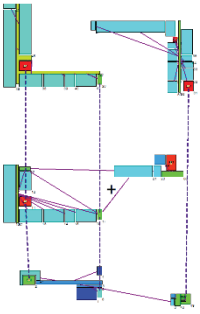
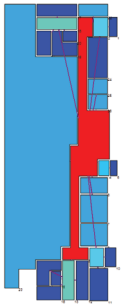
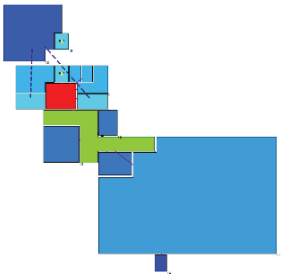
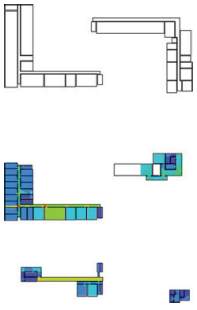
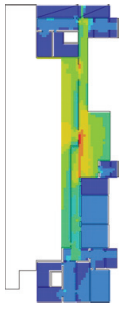
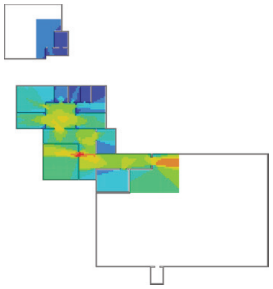
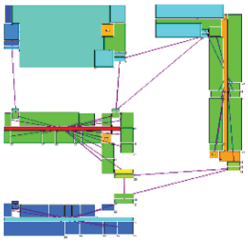
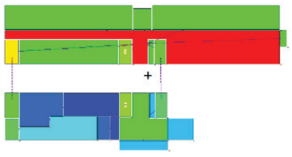
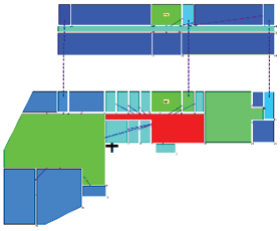
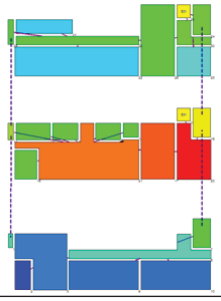
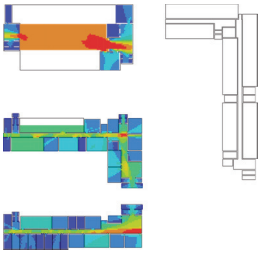
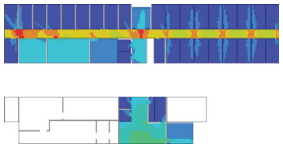
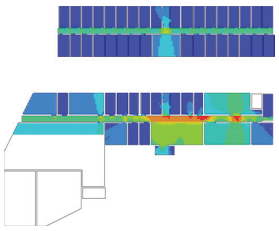
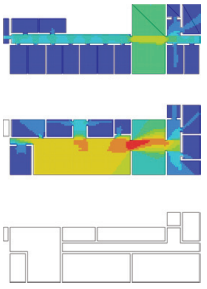
3) Additional method for measuring the validity of CPTED guidelines

For the reason of that, this research proceeded Visibility Graph Analysis (VGA) developed by Turner of University College London in order to adapt visibility toward Space Syntax. VGA is proper to analyse a large open space and it describes the level of isolation in terms of visibility. By analysing the area of space in a diminutive scale, it might compensate the shortcomings of convex map ignoring the unique characteristics of individual space, since a huge volume of convex space is formed at a large open space (Choi, Cho and Kim, 2005).

The result of VGA reveals an interesting point that space which have a high level of integration and control level – corridor, stairs and elevators – actually have a wide range of VGA index in the individual space. In other words, even in the same space, some parts of the space that included its intrinsic spatial characteristics indicates red colour as a vital spot, while the other parts of the place coloured blue indicates the lack of innate traits of the space. For example, corridor consists of red space that is directly connected with the other space and blue space that is partially isolated from the other space though playing a same role.

Also the detail design description of CPTED as several vital spots such as entrance, security hall, corridor and stairs can be translated to visual diagrams through VGA. Since the colour of VGA shows the visibility of individual space by unit square, it could definitely measure whether CPTED detail design advice might be adopted or not in the floor plan design. In terms of security hall in CPTED guidelines, it should be placed to observe every direction of the floor for preventing a crime. However, through the VGA, the visibility at the security hall (purple spot of VGA – Security Hall

Table 4-5 Convex map & VGA

University	A	B	C
Convex Map - Integration			
Visibility Graph Analysis			
D	E	F	G
			
			

section in Table 4-4) cannot cover the whole area of the actual floor plan that should be under surveillance. It means that the floor plan should be modified in a better way to protect students from a crime. The visibility of corridor, entrance and stairs can be exploited in a same process.

In summary, the analogous of the types of space between the CPTED guidelines for residence hall in university and the convex map informs that CPTED guidelines might affect to floor plan design for safety by using space syntax index. However, the convex map analysis is so vague to adopt the CPTED guidelines toward practical design process that the VGA process is needed. The VGA illustrates much more detail results compared to the convex map. Also, those results describe how effectively detail design advice in CPTED would be adapted by using colour diagrams. Therefore, it is reasonable to assert that the VGA proves the validity of CPTED guidelines on practical design process.

5. CONCLUSION

The purpose of this research is to estimate the impact of CPTED guideline that is applicable to the university residence halls to prevent the violent crimes that occur in them. The study was launched with the question, 'Is there a relationship between the characteristics of space in the residence hall described in theoretical CPTED guidelines and that of space designed in practical construction?' If the validity of CPTED guidelines is proven, the

theoretical CPTED guidelines for university residence hall must be adopted in design process as a practical method for reducing the occurrence of violent crime. Therefore, the research should investigate the innate characteristics of space – space configuration, the spatial hierarchy and the level of isolation for individual space – in residence halls through space syntax and VGA and compare it to the theoretical elements in CPTED guidelines to underline the adaptability among them.

The result of convex map indicates a relevant relationship between CPTED guidelines and designing inner space for preventing a crime. Indeed, the VGA result describe how effectively detail design advice in CPTED would be adapted by using colour diagrams. These results proves that the CPTED guidelines will be effective when they are applicable to practical residence hall design so it should be exploited more practically in design process. Since this research focused on only interior space of residence hall with empirical process, the extrinsic elements related to surrounded built environment and social behaviour among residents were neglected. For the increase of credibility of estimate, the further research will include the interview and survey on users as well as staffs in residence halls and mathematical analysis of spatial network.

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