

The Proposal of Quantitative Evaluation Method on Guarantee for Life Safety and Safety Facility

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ABSTRACT: Environmental criminology, study that redesigns environment to prevent crimes, has been actively conducted, and as the result of such studies, there are crime prevention through environmental design. This study suggests the method to evaluate various types of facility installed as series of crime prevention through environmental design campaign to guarantee life safety. It measures the potential criminal danger levels of the target area and evaluates the campaign if it was practiced properly to reduce the level. To do that, we divided the target area into districts and evaluated risk level of each district and suitability of the facility arrangement. We drew the factors with high possibility to cause crimes and accorded weight on how proper the location where the facility was installed to prevent crime is.

Keywords: Crime Prevention, Life safety, Environmental Design

I. INTRODUCTION

Environmental criminology, study that redesigns environment to prevent crimes, has been actively conducted, and as the result of such studies, there are crime prevention campaigns through redesigning environment. The campaign ran in North American and England last decade was successful. There was decrease on quantitative crimes after. Korea introduced the campaign in 2005 and has adopted it as a policy. In 2015, Korean government legislated to adopt the method to redesign the environment to prevent crimes when building more than 500 public housing residents. However, Korean government did not produce positive result as North America or England. Two different outcomes resulted from one method needs to be investigated. The most distinguishing exterior difference of the Korean campaign is that it did not use high-end IT technology. New York city in USA analyze surveillance video in real time and react immediately when discerning criminal activity, however, Korea record it only even though they retain enough Image Processing technology. There must be more reasons other than IT issue that the campaign was not successful in Korea.

This study suggests the method to evaluate various types of facility installed as series of environmental redesign campaign to prevent crimes to guarantee life safety. It measures the potential criminal danger levels of the target area and evaluates the campaign if it was practiced properly to reduce the level. To do that, we drew the factors with high possibility to cause crimes and accorded weight on how proper the location where the facility was installed to prevent crime is. It is meaningful to propose the method to scientifically measure the campaign that is already proceeded, as the development of environmental redesign to prevent crimes in Korea. We expect more enhanced outcome from other campaigns in the future by analyzing the result of the campaign and effectiveness of various facilities installed.

The study is composed as followed; summarize relevant studies on 2, propose the method to evaluate facilities for environmental redesign to prevent crimes on 3, conduct evaluation of actual campaigns carried out on 4, and present the result on 5.

II. RELEVANT STUDIES

2.1 Environmental redesign to prevent crimes

Oscar Newman studied the relationship between public housing in New York and crime rate.

He found out that skyscrapers where lobby, elevators, exits, and more of it is located in dark place hold higher crime rate than small size buildings. He suggested that public area of public housing must be under natural surveillance system. Newman focused on territoriality, natural surveillance, image, and milieu as the significant factors to design defensible space[1].

Herb Rubenstein, Charles Murray, Tetsuro Motoyuma, and Rouse W. [2] extend the concept of natural surveillance that Newman proposed to social surveillance. They define social surveillance: residents watch out

for outsiders' entrance to the neighbor, warn, and intervene with them. Their social surveillance theory brought the assumption that crimes and fear of crimes can be decreased by composing physical environment for social surveillance that effect on constitution of social relationship and harmony among members of the society.

Donald Purlgut[3] evaluated Newman's defensible space too limited. He established manageable space which strengthened the role of maintaining public area more. To utilize manageable space for crime prevention, he proposed it should involve policy management and implement, and designing physical space that is easy for the residents to manage. Broken window theory of James Wilson and George Kelling[4], American criminologist, published in 1982 explains that proper management of the environment and facilities can decrease crimes and fear of crimes with the assumption that one broken window in the area could rise a lot more criminal activities. Study on England city rental housing area of Alice Coleman in 1985 is the representative case study that shows the effect of environment maintenance on crime rate and fear of crime[5]. Many case studies conducted from 1980's to 1990's shows the importance of maintaining environment and facilities, and maintenance has been settled as significant design type for CPTED. Starting from 1980's, many government organizations all over world have recognized and utilized CPTED as an important factor for city plans and city designing.

2.2 Crime Prevention Through Environmental Design

Timothy Crowe[6] organized practical methods for crime prevention through environmental design systematically based on result of existing studies. Prescribed 6 basic principle of Crime Prevention Through Environmental Design; natural surveillance, access control, hardening territoriality, hardening clarity, increasing availability, and maintenance.

Young Hwan Kim[7] defined that CPTED theory started from Newman's defensible space theory. CPTED aims criminals not to be able to commit crimes by changing physical environment that may cause crimes and presuppose that physical environment can be changed and managed to bring behavior result that effect on crime and fear of crime. In addition, CPTED method analyzed that it is possible to decrease crimes and fear of crime and moreover, improve the quality of life by utilizing proper designing and physical environment effectively. Kang Mo Choi, JeongHwa Song, Geon Su Oh (2009) saw that the interest on environmental design for surround area of educational facilities increased as juvenile delinquency of immature teenagers became social issue, and aimed to prevent juvenile delinquency and criminal attempt through CPTED. They categorized recent state, extent of damage, type of juvenile delinquency. They also analyzed physical environment and problems around schools with photos[8].

Dong Gyun Park[9] suggest CPTED operation strategy for safety on university campus, most of his study is to prevent crime on campus by protecting and monitoring through improvement of lights on campus, installing more surveillance cameras, hiring private securities, and so on. Sun Seok Kim.Dae Kwon Kim[10] pointed out psychological damages of crimes that it is significant factor, not material damages only, that define the quality of life. Public area and exterior space work as a type of community where innumerable people share and spend time together, so it is suggested to retain various values. To do that, he insisted that there should be effort to reduce crimes in the way to reduce crime victim and fear of crime in common living space and furthermore, minimize spatial features that are vulnerable to crime and enhance natural surveillance.

Seong Chul Park[11] compared and analyzed CPTED factors and application status of Seoul and kyeong-gi area targeting principals and teachers and analyzed literature to investigate and analyze application and operation of school facilities, and after, he suggested applicable factors based on elicited problems. Moreover, he drew awareness for various characters by area and expected effect by CPTED factors, compared and analyzed the perceived gap between importance by components and group, and finally suggested the order of priority to apply CPTED. Overall in Korea, there have been many CPTED related studies conducted as the value on quality of life, city's safety and comfort rose around 2000. In early years, studies on the issue were mainly conducted through National Police Agency, Police Comprehensive Academy, and such, which ended up as case studies. However, it has been more logical and definite as it expanded to city planning, city design, and construction. Especially, there are more studies on the effect and character of CPTED through analysis study on correlation between crime and CPTED, space analysis, and so on.

III. PROPOSAL

3.1 Evaluation Process

There are list of activities as parts of campaign to redesign environment to prevent crime in Korea as below;

- 1) CCTV installation
- 2) Improve CCTV performance
- 3) Signs that shows CCTV is recording
- 4) Emergency bell installation

- 5) LED light replacement
- 6) Recycling bin installation
- 7) No Littering signs
- 8) Fence installation
- 9) Security grille installation
- 10) Sign installation (SPTED neighbor sign)
- 11) Pergola and bench installation
- 12) Front door and wall painting
- 13) Wall and flower beds installation

Such facility installation intends to restrain crime activities. Installation principle of equipment needs to be reviewed, and the result on reducing crime activities should be explained. We have to measure which crime activities are decreased how much from installing such equipment listed, however, there are no measuring methods prepared. For example, the effect of replacing light bulb of security light to LED on reducing crimes is uncertain as well as prevention rate that we can expect from installing recycle bin.

The campaign is to prevent crimes, so the effect of actions taken must be measured and investigated that they reached the goal so that we could apply it in other area and expect similar result. In other words, we need a proof that qualified principle worked properly to utilize it to design system that fits other requests to prevent crimes and expect crime prevention effect. CPTED in Korea has not been clearly shown specific cases that measure its effect to restrain crime activities from such facilities.

This study suggests evaluation method on facilities installed as a part of environmental redesign to prevent crimes in Korea. The evaluation assesses that facilities of the campaign was proper action to restrain crime activities or not. Result should be shown as quantitative figure.

To assess environmental redesign campaign to prevent crimes, we suggest the process as below;

- 1) Divide target area
- 2) Draw vulnerability on crime and relationship with space through crime activity history from each area
- 3) Calculate the risk rate of crime by area
- 4) Check campaign facilities by area
- 5) Assess suitability on the campaign by area
- 6) Draw result

Crime does not occur at one area. Crime observes the target, measure attractiveness of it, and check the defensibility of it, presence of witness, or any obstacle that interrupt criminal action. Such process correlates with time and space, so it is safe to say that crime connects itself with an area and occur there constantly, not at the special spot.

Therefore, we divide area, assess facilities in each area overall, and also connectivity among areas to evaluate the environmental redesign campaign properly. In that way, the process as to 1) Divide target area, 2) Draw vulnerability on crime and relationship with space through crime activity history from each area, 3) Calculate the risk rate of crime by area, 4) Check campaign facilities by area, 5) Assess suitability on the campaign by area, and 6) Draw result, has viability(feasibility).

Next, we implement the process and mathematize it.

3.2 Modeling the evaluation process

Evaluating public safety with number of surveillance cameras, or lights in a broad area greater than an area, 300m and 500m in each dimension causes a problem not to consider the arrangement, condition, and more issues of actual facilities for public order. Therefore, we need to divide the area into n districts according to main roads, or density of buildings in the area and assess the score of districts. After, total up each assessment to calculate the score on public safety improvement campaign.

We can create distinct vectors for districts when dividing the area into n districts

For example, divide A area into n districts,

$$A = \{a_1, a_2, \dots, a_n\} \quad (1)$$

Generate a set that holds n vectors as element.

Each vector has value for p valuation criteria.

Define distinct vector a_k with vector $(f_1, f_2, f_3, \dots, f_n)$

So, it is $a_k = (f_1, f_2, f_3, \dots, f_n)$.

Distinct vector is characteristic the district has; number of surveillance cameras, or light.

Let's say weight score vector for each valuation criteria is as below.

$$w_k(a_k) = (w_{k1}(a_k), w_{k2}(a_k), \dots, w_{kp}(a_k)) \tag{2}$$

w_k is transformative weight, not fixed value, that could be changeable with input value, a_k , because the effect of facilities on crime prevention could change depends on environment, number of crimes, and more factors of a specific district. For example, lights in a district play its role as crime prevention effectively, but in another district, it could expose citizens to potential criminals.

Now, calculate scores of districts with vectors.

Score of district from vector could be calculated by $s_k = w_k^T a_k$.

Total up the score all distinct vectors, and it is

$$S = \sum_k w_k^T a_k \tag{3}$$

We conduct positive evaluation when it is $S > 0$, negative evaluation for $S < 0$. When it is $|S| > 5$, it is very high, $|S| < 2$ indicates insignificant, and consider normal when it is between 5 to 2. For example, when $S = 2.5$, usually it is positive, $S = -1$ will be considered as negative. $S = 10$ will be highly positive.

IV. EXPERIMENT AND EVALUATION

Conduct evaluation on the project implemented in Seongjung-dong Seobuk-gu, Cheonan-si in accordance with 3 pages of suggestion. Divide target area into n districts, and then, calculate and evaluate. Divide the area mainly with high frequency on crimes and area with facilities.



Fig.1 Divide target area(Seongjung-dong Seobuk-gu, Cheonan-si)

As above, 10 vectors are created.

Think about components values of each vector on $a_k = (f_1, f_2, f_3, \dots, f_6)$.

f_1 is number of surveillance camera, and it is whole number value.

f_2 is number of security lights, and it is whole number value.

f_3 is number of security grille installed, and it is whole number value.

f_4 is number of emergency bell, and it is whole number value.

f_5 is frequency of theft occurred. Give score from 0 to 10 in accordance with the actual frequency of crime.

f_6 is frequency of sexual assault. Give score from 0 to 10 as well.

Weight score vector is as below;

$$w_1 = \begin{cases} 1 & \text{(if } f_5 > 0 \text{ or } f_6 > 0 \text{ or } f_1 = 1) \\ -1 & \text{(if } (f_5 = 0 \text{ or } f_6 > 0) \text{ or } f_1 > 1) \\ 0 & \text{else} \end{cases} \tag{4}$$

Give score as the number of surveillance cameras when it is installed. If several units are installed in a place, or at a place where crime does not occur frequently, subtract score.

$$w_2 = \begin{cases} 1 & (\text{if } f_5 > 0 \text{ or } f_6 > 0) \\ -1 & (\text{if } f_5 = 0 \text{ and } f_6 > 0) \\ 0 & \text{else} \end{cases} \quad (5)$$

Give score for the security lights installed at a place where crime occurs frequently. If it is installed where criminal activity occurs relevantly rare, subtract score.

$$w_3 = \begin{cases} 1 & (\text{if } f_5 > 0) \\ -1 & (\text{if } f_5 = 1) \\ 0 & \text{else} \end{cases} \quad (6)$$

Give score for the security grille installed where theft occurs frequently. If it is installed where such criminal activity occurs relevantly rare, subtract score.

$$w_4 = \begin{cases} 1 & (\text{if } f_6 > 0) \\ -1 & (\text{if } f_6 = 0) \\ 0 & \text{else} \end{cases} \quad (7)$$

Give score for the emergency bell installed where sexual assault occurs frequently. If it is installed where such criminal activity occurs relevantly rare, subtract score.

$$w_5 = \begin{cases} -1 & \text{if } (f_1 = 0 \text{ or } f_2 = 0 \text{ or } f_3 = 0) \text{ and } f_5 > 0 \\ 0 & \text{else} \end{cases} \quad (8)$$

If surveillance camera, security grille, security lights, and more are not installed for theft activity that occurs often, subtract score.

$$w_6 = \begin{cases} -1 & \text{if } (f_1 = 0 \text{ or } f_2 = 0 \text{ or } f_4 = 0) \text{ and } f_6 > 0 \\ 0 & \text{else} \end{cases} \quad (9)$$

If surveillance camera, security lights, emergency bell, and more are not installed for sexual assault activity that occurs often, subtract score.

Actual value calculated in accordance with evaluation standards and formulas above is as below;

$$S = (0 \ 1 \ 0 \ -1 \ -1 \ 0) \begin{pmatrix} 0 \\ 3 \\ 0 \\ 1 \\ 3 \\ 0 \end{pmatrix} + (-1 \ -1 \ 0 \ -1 \ 0) \begin{pmatrix} 1 \\ 4 \\ 0 \\ 2 \\ 0 \\ 0 \end{pmatrix} + \dots + (-1 \ -1 \ -1 \ -1 \ 0) \begin{pmatrix} 1 \\ 6 \\ 1 \\ 1 \\ 0 \\ 0 \end{pmatrix}$$

Table.1 Actual value calculate

Area number	CCTV	Security lights	Security grille	Emergency bell(button)	theft	Sexual assault	score
1	0	3	0	1	3	0	-1
2	1	4	0	2	0	0	-7
3	0	3	0	0	3	0	0
4	0	2	0	0	2	0	0
5	1	4	1	1	3	3	+13
6	0	3	0	0	2	0	+1
7	0	8	2	0	0	0	-10
8	2	10	1	1	1	0	-8
9	2	9	0	2	1	1	+13
10	1	6	1	1	0	0	-9
Total							-8

The total comes up as -8, it is very negative.

It became the target of criticism that there was no additional crime prevention facility installed in the area, but duplicated crime prevention facility at an area that are not analyzed as dangerous. This study is worth enough with the fact that it allows to conduct quantitative evaluation on crime prevention campaign facilities beyond heuristic analysis of experts and intuitive evaluation of users.

V. CONCLUSION

Environmental redesign campaign to prevent crime in Korea started in 2005. It has not been shown remarkable result and established detailed application principle yet. Therefore, this study suggests method to evaluate details of environmental redesign campaign to prevent crime quantitatively. We divided the target area into districts and evaluated risk level of each district and suitability of the facility arrangement. With this study,

we expect to contribute to successful application and productive outcome of environmental redesign campaign to prevent crimes in Korea. In addition, government institutes apply the result of the study on arrangement and installation of facilities for the campaign so that they improve the usability and decrease crime rate.

ACKNOWLEDGEMENTS

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education(NRF- 2015R1D1A3A01017968)

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