Effectiveness of a Project Applying Crime Prevention through Environmental Design in an Urban Area in South Korea

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Abstract

With increased attention being paid to Crime Prevention Through Environmental Design (CPTED) in crime-prone areas, a demo-project was mounted in Mapo-gu Yeomri-dong in South Korea to reduce crime rate and fear of crime. Preceding studies on the project have assessed only reduction in fear of crime, by surveying residents and non-residents; the present study uses actual incremental crime data from target areas before and after CPTED application to identify change in crime rate, using the quantitative analysis method WDQ. Results illustrate that theft decreased where CPTED was applied but increased in nearby areas, while violent crime increased in both types of area. These results show that CPTED reduces the rate of property crime but has no effect on violent crime.

Keywords: CPTED project; crime displacement; crime prevention; WDQ; safe avenue

1. Introduction

1.1 Background and Purpose of the Study

Mapo-gu Yeomri-dong in Seoul, the South Korean urban area that first applied CPTED (Crime Prevention Through Environmental Design) to reduce fear of crime as well as the crime rate in Korea, has become a benchmark for many other Korean provinces and cities to evaluate their own levels of CPTED against crime. In June 2012, Mapo-gu Yeomri-dong was selected as a CPTED target area as part of UNESCO's "Creative Cities Project"; subsequently, a 1.7 km trail called the "Salt Way" was created, in which CPTED principles were applied through the integration of visual crime-preventive elements (e.g., colors and graphics) and physical crime-preventive elements (e.g., lights, IP cameras, and safety fences).

In 2013, after the creation of the Yeomri-dong Salt Way, numerous news stories reported positive reviews and promising academic results on the Salt Way, with titles like "The three new demo-project areas selected in Joongrang-gu Myeon-mok 4.7-dong after the realization of its actual effect," "The rebirth from crime-prone area to safety village," and "Yeomri-dong Salt Way: its crime rate plunges through pictures." Studies on the Yeomri-dong project highlighted the positive effects of CPTED in Salt Way, accentuated its effectiveness, and fed expectations regarding the effect of crime-preventive design in Seoul. However, these studies relied on surveys of residents regarding their fear of crime and their satisfaction with CPTED to show the effectiveness of the approach, and did not rely on actual crime rate reduction data. Hence, these studies were not able to fully assess the effectiveness of the CPTED project.

This study uses actual crime data as the basis for analyzing the effectiveness of the CPTED project in Yeomri-dong by applying the Weighted Displacement Quotient (WDQ), a quantitative analysis method that evaluates the success/failure of a crime control strategy.

1.2 Method and Scope of the Study

The method of investigation was as follows. First, the validity of existing study results was assessed to evaluate the success/failure of the crime control strategy. Next, WDQ analysis was selected as the primary method for this study, based on a thorough review of existing studies. Last, the study compared the crime rate between areas affected and not affected by CPTED using WDQ analysis before and after CPTED, and using the difference between the two measurements as the standard for the effect of CPTED. The scope of the study was restricted as follows. Geographically, the study selected only certain areas around the Mapo-go Yeomri-dong Salt Way, for...
2. Literature Review

2.1 Studies Related to the Assessment of Crime-Prevention Design

As mentioned above, preceding studies have evaluated the effectiveness of the crime-prevention project in Yeomri-dong based on surveys of residents. Park (2013) conducted such a survey, using perceived change in village environment and subjectively evaluated psychological fear as measures of the effectiveness of the CPTED project. Cho (2013) used residents’ awareness of facilities established through the project and their satisfaction with the project as measures of its effectiveness. Lee (2013) selected fear of crime as one of the factors to assess the effectiveness of the project.

The approach used by these studies has obvious limitations, however. First, fear of crime is a personal feeling, and is therefore not an objective or comprehensive evaluation of the CPTED project, which aims to reduce not only fear of crime but also the actual crime rate. Second, since the geographical target area was restricted to the Salt Way, this approach does not consider the possibility of crime displacement, making it inadequate for assessing the overall effectiveness of the project. Park (2013) showed that the degree of fear of crime that target area residents and non-residents felt was different; this implies that crime displacement to nearby areas must be a facet of the project’s effectiveness also. Third, the preceding studies took place within the first year after the project was conducted, and thus did not provide information on the persistence of effects, whereas sustainability of results is one of the criteria by which CPTED must be evaluated. Furthermore, this data collection period was insufficient for the assessment of the backwardness of the previously established facilities and the durability of the regional community after the project.

In order to address these limitations of preceding studies, the present study uses actual crime data to evaluate the effectiveness of the project through WDQ analysis, a quantitative analysis method that evaluates the crime displacement effect on areas near Salt Way. Such analysis will allow for a broader perspective on the benefits of CPTED for crime control.

2.2 WDQ Studies on Crime Control and Crime Displacement

Previous studies have utilized WDQ analysis to assess the success/failure of crime control strategies on the basis of actual crime data (Bowers and Johnson 2003). WDQ is the appropriate analysis method for estimating increased crime (crime displacement) or decreased crime (diffusion of benefit) in nearby areas along with crime control (decrease) in the area in which the crime control strategy is implemented. WDQ allows for comparison between before and after implementation of preventive measures in different areas, down to specific neighborhoods and even buildings, in order to evaluate the effectiveness of these measures. WDQ sets the "treatment area" as the area in which the crime-preventive strategy is applied, the "buffer area" as the area expected to bear the burden of crime displacement phenomenon due to the crime-preventive action in the treatment area, and the "control area" as the area not influenced by changes in the treatment area or the buffer area. Given this approach, the relative distribution of crimes across regions is more important for the WDQ than the absolute number of crimes.

In order to examine the diffusion of crime (crime displacement) and of the control benefit—in this case, of a building's crime alarm in a residential area—Lee (2008) set the target building as the treatment area, the building next to it as the buffer area, and the building next to that building as the control area. A study by Harada (2008) set its treatment area, buffer area, and control area on the basis of absolute distance, taking 50 m as a base unit, while Bowers and Johnson (2003) subdivided the target zone into five phased buffer areas separated at 400 m intervals, in a concentric circle. McLennan and Whitworth (2008) also investigated the effects of different crimes and their diffusion on the basis of absolute distance. Park, Hwang, and Kim (2011) analyzed displacement of theft and violent crime after the introduction of CCTV, using the neighborhood (administrative district) as their base unit.

Setting an appropriate base unit of analysis for drawing treatment, buffer, and control areas in such a study is crucial (Ratcliffe and Breen 2011), and needs to be securely justified; simply setting a standard-sized radius or series of radii, as several previous studies did, does not seem adequate, since there is no particular reason to think that these zones have the same characteristics. To a lesser extent, the same goes for administrative districts as well.

This study therefore takes into account physical features and obstacles within visible distance in treatment areas (e.g., steep slopes, visual obstruction due to stairs), which may meaningfully influence crime displacement (and/or diffusion of crime reduction), in order to assess the effects of CPTED on target and surrounding areas.

3. Analytical Framework

3.1 Target Area of the Analysis

The target area in this study is the regions in Yeomri-dong, in Seoul, in which CPTED was first applied. Yeomri-dong is a typical old downtown residential area, built on hillsides with steep slopes, traversed by narrow alleys. Regular houses are constructed to face each other across each avenue. The socioeconomic status of the residents is generally low, and people
suffer from frequent crime in the area (Park, 2013). Hence, in order to reduce fear of crime and crime rate, the principles of CPTED were applied to the existing narrow, dark avenue, and the place was renamed "Salt Way" from the name of the original village on the site.

Salt Way is 1.7 km long (Fig.1.), and its physical crime-preventive elements include 6 SOS Houses, 5 CCTV cameras, and 6 IP cameras, along with visual crime-preventive elements such as LED streetlamps for pedestrians, floor patterns and various sculptures. The principles of CPTED—surveillance, reinforcement of activity, maintenance, and reinforcement of territoriality—were applied to all sections of the Salt Way trail. Table 1. illustrates the principles of CPTED and elements representing them in the Yeomri-dong Salt Way.

### 3.2 Crime Data

This study secured crime occurrence data ("where and when" information for different types of crime) from 2011 to 2013, that is, covering both before and after, when the CPTED project was implemented in Yeomri-dong, in 2012. In order to examine the actual effect of crime-preventive environmental design, the study restricted the types of crime considered in the analysis to theft, which is known to be heavily influenced by nearby environment, and violent crime, which is mainly caused by people acting with the intent to commit theft or by accident; thus, it is only slightly influenced by nearby environment. Furthermore, the study restricts the crimes considered to those occurring between 1200 h and 1800 h, which is the time period during which the elements of crime-preventive design are most easily recognizable due to better visibility and in which theft occurs most frequently.

### Table 1. Principles and Elements of CPTED in Salt Way

| Principle                  | Element                                          |
|----------------------------|--------------------------------------------------|
| Surveillance               | Securing visibility by improving lighting and removing obstacles; IP cameras, CCTV |
| Reinforcement of activity  | SOS House, floor graphics (play facilities in alleys), exercise facilities |
| Maintenance                | LED streetlamps for pedestrians, floor patterns |
| Reinforcement of Territoriality | Village board, safety fence design              |

Fig.1. Elements of CPTED in Salt Way

Fig.2. Crime Map of Yeomri-dong Salt Way
Excluding the crimes occurring in unknown locations within Yeomri-dong, in 2011, there were 35 thefts and 46 violent crimes; in 2013 there were 49 thefts and 53 violent crimes (Fig.2.). Then, excluding crimes that occurred in areas outside the scope of this study (to be divided into treatment, buffer, and control areas) or that occurred within the complex in the target area, there were 28 thefts and 41 violent crimes in 2011 and 42 thefts and 41 violent crimes in 2013.

### 3.3 Setting WDQ Areas

This study divides the area to which WDQ analysis is applied into the treatment area, buffer area, and control area, as discussed above. Dividing up the area is very important, because the results of analysis could significantly differ across areas (and across methods of dividing them up).

Since the principles of CPTED were applied in Yeomri-dong Salt Way at the avenue level, this study sets its three areas based on street segments. First, the treatment area is set as a segment that is influenced by the crime-preventive effect, since it overlaps with part of Salt Way to which the crime-preventive design was applied (Fig.3.). The treatment area is the avenue on which crime-preventive activities were focused.

Next, the buffer area is set as the avenue near a segment of street where crime-preventive design was applied but was hard to recognize due to visual obstacles (stairs due to hillside, curved alleys, discontinuity of Salt Way due to fence; see Fig.4.).

Last, the most important factor for setting a control area is that it should have similar conditions with the treatment area. Yeomri-dong stretches from south to north, and its low-rise, residentially populated expanse divides naturally into south and north parts due to an apartment complex located around the middle (Fig.2.) that separates the south and north parts and means that although both areas have very similar environmental conditions, the south residential area can be considered to be unaffected by the CPTED project, that is, the control area, and the north area to contain the treatment...
area and buffer area; the north and south areas are around the same size, as seen in Figs.5. and 6.

4. Results

4.1 Crime Rate Trends

The WDQ analysis first compares incremental crime rate between 2011 and 2013, recalculated for consistency as the number of crimes per 100,000 people. The results show that the number of theft crimes increased from 155 to 264 (about 1.7 times greater), while the number of violent crimes increased from 410 to 414 (about 1.01 times greater).

These numbers are then broken down on the basis of the treatment area, buffer area, and control area in order to analyze the effectiveness of CPTED through the diffusion of crime and of crime control. Table 2. presents the results for the buffer area and the control area.

Table 2. Number of Thefts and Violent Crimes by Year

| Category          | Crimes per 100,000 pop. | 2011 | 2013 | 2011 | 2013 |
|-------------------|-------------------------|------|------|------|------|
|                   | Per 100,000 | Per 100,000 | Per 100,000 | Per 100,000 |
| Treatment area (A) | 11          | 61       | 14    | 89    | 13    | 72    | 14    | 88    |
| Buffer area (B)   | 6           | 33       | 10    | 62    | 17    | 94    | 16    | 100   |
| Control area (C)  | 11          | 61       | 18    | 113   | 16    | 89    | 11    | 69    |
| Total             | 28          | 155      | 42    | 264   | 46    | 255   | 41    | 257   |

※ Population of Yeomri-dong: 18,063 in 2011, 15,929 in 2012 (KOSIS, Korean Statistical Information Service)

The incremental crime rates of the control area in relation to the treatment area (A’) and the buffer area (B’) were different in terms of theft and violent crime, as shown in Table 3. The rate of theft was -0.222 in the treatment area compared to the buffer area, implying a relative though not an absolute decrease from 2011 to 2013; in the buffer area, the overall change is positive (0.010), implying that the crime rate in the control area is higher than during the previous year (Table 3.).

Table 3. Impact of CPTED on Theft

| Theft crime                  | Note               |
|------------------------------|--------------------|
| Incremental crime rate in the treatment area (A’) | Incremental crime rate in the buffer area (B’) |
| WDQ                          |                    |
| Of control area (A’)         | -0.222             | 0.010       | -0.045   |
| (decreased)                  | B’> 0, increased   | -1<WDQ<0    |

The difference in crime rate in the control area relative to the treatment area after versus before the implementation of CPTED is 0.460,a positive result. The crime rate in the buffer area (B’) is 0.392 (see Table 4.).

Table 4. Impact on Violent Crime

| Violent crime | Incremental crime rate in the treatment area (A’) | Incremental crime rate in the buffer area (B’) | WDQ |
|---------------|---------------------------------------------------|------------------------------------------------|-----|
| Of control area (A’) | 0.460 (A’> 0, increased) | 0.392 (B’> 0, increased) | 0.852 (0<WDQ<1) |
| Note           | Positive net effect of the program               | Positive net effect of the program               | No effectiveness |

4.2 Results of WDQ Analysis

Using the incremental crime rates of the control area (C) relative to the buffer area (B) and to the treatment area (A) before (t0) and after (t1) the implementation of the crime-prevention project, a WDQ index is calculated. The equation for the index is:

\[ WDQ = \frac{Bt_1/Ct_1 - Bt_0/Ct_0}{At_1/Ct_1 - At_0/Ct_0} \]

The WDQ index is based on 1, 0, and -1, and can be considered representative of the diffusion of the benefit of crime control (the phenomenon of decreased crime in the buffer area), the direct effect, and the crime displacement effect (increased crime in the buffer area). The WDQ index is higher than 1 when the treatment area (A’) and the buffer area (B’) both have positive signs after the implementation of the project, and this indicates that the incremental crime rate in the buffer area is higher than in the treatment area. This would mean that the diffusion effect of the crime control benefit is very strong. On the other hand, when A’ has a positive sign, B’ has a negative sign, and the WDQ index has a negative sign, this means that the incremental crime rate in the buffer area has increased after the project, implying that there was crime displacement from the treatment area to the buffer area.

The degree of crime displacement can be identified on the basis of 0 and -1. For instance, a -1 that has different signs but the same values can be considered the absolute limit of crime transfer.

In the case of theft, the WDQ is between -1 and 0, and the signs for the treatment and buffer areas are different. When comparing absolute values, the crime rate in the buffer area (B’) has the higher value, with a WDQ index of -0.045 (Table 3.). This indicates that the crime rate in the control area in relation to that in the buffer area is decreased (Table 4.).
treatment area has decreased by 0.222, while the crime rate in the buffer area has increased by 0.010. Since WDQ is between -1 and 0, this can be interpreted as showing that the CPTED project decreased the crime rate in the avenue where it was applied but caused crime displacement to nearby areas (see Table 5).

In the case of violent crime, the incremental crime rate of the control area in relation to the treatment area (A') shows a positive result, which diverges from the expected decrease in crime rate in the control area. However, given that many violent crimes are the result of accidents, it may be that CPTED has less of an ability to have an effect on this sort of crime (see Table 5).

Hence, in the case of Salt Way, which was created to discourage criminal ideation and to improve the environment, prevention seems to have been effective for theft, which is influenced by situational opportunity factors, but to have been weak in influencing accidental violent crime.

5. Discussion
In the case of theft, a decrease in the crime rate in the control area relative to the treatment area is the expected result after the implementation of a crime-preventive design project. In fact, there was a weak influence of the project on the street where the CPTED principle was applied, since it reduced the actual crime rate in the target area. However, the incremental crime rate of the control area compared to the buffer area was positive, and the WDQ was between -1 and 0, indicating that crime in the treatment area was displaced to the buffer area. In other words, the crime of theft, which is influenced by the opportunity to commit it, was displaced to the buffer area, where there were no crime-preventive design elements.

As for violent crime, the crime rate in the control area increased in relation to both treatment and buffer areas. The increase in relation to the treatment area could be interpreted as evidence that the CPTED project does not affect violent crime. Moreover, since the CPTED project saw no effect in the treatment area before its effectiveness in the buffer area was assessed, the study cannot reach a clear conclusion on this point. This result parallels those of research abroad that show only a non-significant correlation between CPTED and reduction of accidental crime rate (Deisman 2003).

6. Conclusion
This study utilized the WDQ analysis method to gauge the effectiveness of the CPTED project, an environmental design initiative for crime reduction that was applied to Yeomri-dong, based on the data for crime displacement and/or diffusion of crime reduction. The study focused on the crime of theft, which is known to be heavily influenced by the nearby environment, and violent crime, which mainly accompanies theft or occurs by accident, and therefore is only slightly influenced by nearby environment. By comparing and analyzing data for these two forms of crime across treatment, buffer, and control areas, the study determined the following results.

First, in the case of theft, the crime rate decreased in the avenue where physical crime-preventive design elements were easily recognizable, due to the reduction in situational opportunity factors, but actually increased in nearby avenues where the realization of these crime-preventive design elements was impossible due to visual obstacles. As for violent crime, incremental crime rates in the treatment area and buffer area after the CPTED project both increased. This implies that crime-preventive environmental design does not have an effect on violent crime.

To summarize, violent crime increased by 1.70 times, while theft decreased slightly, by 1.01 times, in the period after the application of the CPTED project. Given these results, the project does not seem to have had the desired influence. While the CPTED project applied to Salt Way, Yeomri-dong, had an influence on that specific street, it does not seem to have been effective in reducing the overall crime rate in the area. Therefore, the CPTED project may be tentatively concluded to have only local effects.

This study has contributed to the literature by evaluating crime rate based on actual crime data, unlike previous evaluations of the effectiveness of the CPTED project that focused on the reduction of the fear of crime. However, this study is limited in terms of its ability to isolate varying degrees of effectiveness of each crime-preventive design element. Hence, microscopic evaluation of the effectiveness of individual crime-preventive design elements in Yeomri-dong should be conducted in order to come up with designs that could yield better effects in future projects.

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Note
An SOS House is a house that allows victims to request help or helps them escape or deal with a dangerous or emergency situation such as a crime occurring in Salt Way or nearby (Park 2013).

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