범죄예방 환경설계(CPTED) 고도화 및 인증제도 개선 방향

Enhancing CPTED and Crime Prevention Building Certification System

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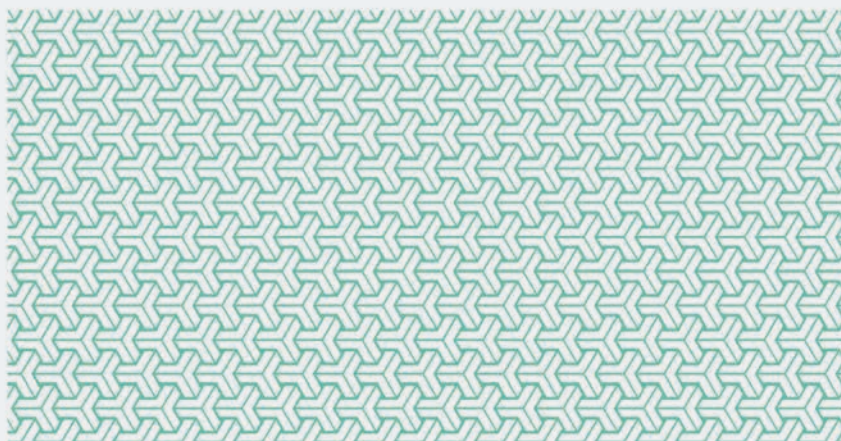**권오규** Kwon, O Kyu
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Chapter 1: Introduction

In South Korea, Crime Prevention Through Environmental Design (CPTED) has been actively introduced in policy projects and other initiatives, entering its maturity phase. Consequently, there is growing interest in verifying the sustainability of CPTED interventions and their crime prevention effectiveness. However, there are also cases where initial CPTED projects have been poorly managed or have failed to achieve the intended outcomes. This is due to the fact that although the physical environment of buildings, cities, and communities are organically interconnected, each project and policy only achieves goals within its individual scope, resulting in limited overall crime prevention effects.

To address this issue, integrated physical environment improvements in architecture and urban spaces are crucial. By systematically verifying the effectiveness of CPTED and implementing policies based on these findings, crime prevention effects that encompass urban spaces, public facilities, and private buildings can be expected. Currently, there are various systems related to CPTED, such as urban space environmental improvement projects, crime prevention environmental standards for buildings, and the private building crime prevention excellence certification program. This study focuses on the certification program aimed at encouraging private sector participation and discusses ways to improve it. Furthermore, to analyze how physical environment factors impact crime for policy-making, an analysis was conducted in areas without CPTED projects from the central government. This analysis aimed to identify the relationship between physical environment characteristics and crime occurrence and propose improvements to enhance the crime prevention effects of CPTED projects.

The goal of this research is to identify the linkages between spatial environmental elements and crime prevention factors, discuss the direction of CPTED, and explore ways to encourage private sector participation to strengthen crime prevention in private buildings. To achieve this, the study derives physical environment factors that should be included in crime prevention strategies, and proposes strategies to enhance participation and effectiveness in private building crime prevention. The study analyzed the impact of physical environment characteristics of buildings and urban spaces on crime occurrence, derived relevant variables, and collected expert opinions to evaluate the effectiveness and

need for the expansion of the National Police Agency's private building CPTED certification program.

Chapter 2: Analysis of Physical Environment Factors Related to CPTED

This chapter reviews prior studies on crime prevention through environmental design and identifies physical environment factors related to crime prevention. The physical environment factors were analyzed by categorizing them into architectural elements and spatial environmental elements, with factors derived from prior CPTED studies and key projects by the National Police Agency and the Ministry of Justice. Among the five principles of CPTED, the study focused on access control, surveillance, and territoriality, which are closely related to the physical environment. Specific cases analyzed include major prior studies, the National Police Agency's crime prevention building certification checklist, and the Ministry of Justice's regional crime prevention environmental improvement consulting materials. The physical environment factors derived from this analysis will be used as independent variables in the next chapter for analyzing the impact on actual crime occurrences.

In the analysis of prior CPTED studies, six studies focusing specifically on physical environment characteristics were selected to derive architectural and spatial environmental elements. These were classified according to the main CPTED principles of access control, surveillance, and territoriality. Architectural elements include clear entrances, locks, intercoms, CCTV, sensors, and safe lighting design. Proposals for enhancing surveillance include using transparent materials for open building layouts and installing CCTV to improve visibility. Furthermore, the study discusses strengthening territoriality through clear distinctions between private and public spaces, design reflecting local characteristics, and resident-participatory designs. Spatial environment elements include creating open, wide spaces instead of narrow, long alleys, enhancing natural surveillance, and establishing safe zones. Moreover, the study suggests measures to prevent crime by ensuring adequate lighting through streetlights and security lights, and by creating community spaces such as rest areas, playgrounds, and community facilities.

In the analysis of the National Police Agency's Crime Prevention Excellent Facility Certification Program, the checklist was examined to derive architectural

elements. The certification program, which began in 2016 for parking lots and expanded to small residential buildings in 2018, aims to promote crime prevention environmental improvements in private facilities. The checklist is composed of categories such as management and operation systems, design, and security and safety facilities, with evaluation criteria based on the CPTED principles of access control, surveillance, and territoriality. Access control includes installing entry control systems and reinforced security devices at entrances and windows, and applying measures to block intrusion routes in outdoor spaces. Surveillance emphasizes natural and video surveillance, minimizing visual obstructions, removing blind spots and hiding spaces, and requiring high-resolution CCTV for 24-hour monitoring and video storage. Territoriality is secured by applying boundary markings and design elements to walkways and parking lots, as well as considering the needs of vulnerable pedestrians. Additionally, principles of functionality and maintenance are incorporated by arranging commercial and community facilities to activate activities and requiring maintenance of the facilities.

In the analysis of the Ministry of Justice's crime prevention environmental design projects, regional crime prevention environmental improvement consulting materials were examined to derive spatial environmental elements. Initially, these projects were promoted through collaboration with private sectors and local governments but, since 2016, have expanded in scale and expertise through partnerships with the Ministry of Land, Infrastructure, and Transport and the Ministry of the Interior and Safety, linking urban regeneration and safety projects. From 2019, these initiatives have been linked to urban regeneration new deal projects, industrial complex regeneration projects, and fishing village new deal projects, and since 2024, rural center revitalization projects have also been included. The most recent three years of projects were analyzed based on architectural and spatial environmental elements following the CPTED principles of access control, surveillance, and territoriality. Access control in architectural elements considers factors such as the location of entrances and windows, building age, and the number of vacant houses, while spatial elements include shielding vacant land and the proportion of parks and green spaces. To enhance surveillance, architectural elements focus on the placement of entrances and stairwells, installation of CCTV and lighting, while spatial environmental elements emphasize surveillance equipment and lighting for alleys and blind spots. To ensure territoriality, architectural elements include fence placement

and the proportion of mixed–use areas, while spatial elements focus on preventing illegal dumping and designating protection zones.

Chapter 3: Analysis of Architectural and Urban Physical Environment Characteristics at Crime Occurrence Points

This chapter aims to analyze the impact of architectural and urban physical environment characteristics on crime occurrence and provide the basis for integrated strategies in crime prevention through environmental design. The target areas for analysis are six districts in Seoul (Seocho, Gangnam, Songpa, Gangdong, Geumcheon, and Eunpyeong), selected based on high crime rates, crime occurrence, and per capita crime rates. Some analyses were carried out focusing on four districts (Seocho, Gangnam, Songpa, and Gangdong), where spatially continuous analysis was possible. The target areas were analyzed by aggregating crime occurrences and physical environment characteristics in 250–meter grid units.

The analysis method is composed of three main stages. First, the impact of the police department's crime prevention certification on crime occurrence was analyzed to assess the crime prevention effectiveness of certified facilities. Second, the impact of physical environment factors on crime occurrence was analyzed through regression analysis (OLS), machine learning (Random Forest), and spatial regression analysis (MGWR). Spatial correlations between major physical environment variables and crime occurrences were assessed to identify how these variables influenced crime across different areas. Models analyzed crime types (violence, theft, etc.) and occurrence times (day, night, etc.). Data preparation involved collecting population, crime data, and urban environmental variables, and deriving relationships between major variables and crime occurrences through OLS regression. In machine learning (Random Forest), the importance of variables was evaluated, and through spatial regression analysis (MGWR), the differentiated impacts of physical environment factors on crime were analyzed by region.

First, using the police department's crime prevention certification and crime data for six districts of Seoul, the characteristics of certified facilities and crime occurrence trends were analyzed. The analysis focused on 24 certified facilities,

selected from 130 facilities initially certified between 2021 and 2023, for which data was available. These facilities included parking lots and one-room apartment buildings, and crime data before and after certification was compared to assess the effectiveness of the certifications in preventing crime. The crime data was processed to exclude duplicates, identify the five major crime categories, and convert address information into coordinates, leaving 24,879 incidents for analysis. Descriptive statistics showed that violence (16,394 incidents) and theft (9,058 incidents) were the most common crimes, with a decreasing trend in crime incidents over the years (9,961 incidents in 2021, 8,146 incidents in 2023). In the analysis of the effectiveness of certified facilities, crime rates before and after certification were compared within a 100-meter radius and at the building level. A 25% reduction in crime rates was observed within the certified facilities and a 16% reduction within a 100-meter radius, though these reductions were not statistically significant. This result was attributed to the limited sample size, and the interpretation also took into account the trend of decreasing crime rates over the years.

Next, regression analysis, machine learning, and spatial regression analysis were conducted. Physical environment variables selected from prior studies, police department's CPTED certification checklist, and Ministry of Justice projects were gathered through public data sources and reclassified according to population and physical environment characteristics. Population was treated as an independent variable, and the remaining physical environment variables were categorized into land use, road network, building forms, street facilities, and building usage. Physical environment data was obtained from a variety of public data sources such as VWorld, local government administrative approval data, public data portals, and Kakao API. The analysis was conducted on a 250-meter grid unit, and the dependent variable (crime occurrence) was processed either as a binary classification or continuous variable according to the model's characteristics. Only crimes occurring at the building level were included in the analysis. After adjusting the scale of variables, outliers and missing values were addressed, and variables with low multicollinearity and correlation coefficients were selected for analysis.

The analysis showed that in most models (OLS regression, Random Forest, MGWR spatial regression), population density was positively correlated with crime occurrence. Among land use factors, commercial and mixed-use areas showed a positive correlation with crime occurrence, while green spaces showed

a negative correlation. In road networks, road width was positively correlated with crime, while pedestrian pathway area showed a negative correlation. Building—related elements such as the number of buildings, floor area ratio, and building coverage ratio were positively correlated with crime occurrence, and some building heights showed a non—linear relationship. The relationship between the number of CCTV cameras and crime occurrence showed mixed results, including both positive and non—linear correlations. Regarding building usage, restaurants and convenience stores showed a positive correlation with crime, while cafes and office buildings showed a negative correlation. In conclusion, factors such as population density, commercial area density, and green space had a significant impact on crime occurrence, while the relationship between CCTV installation and crime prevention requires careful interpretation, as it may not be causally linked.

Chapter 4: Deriving Directions for Environmental Design and Certification Program Improvement for Crime Prevention

Based on the analysis of the impact of physical environment factors on crime occurrence, the aim is to advance crime prevention through environmental design and evaluate the performance of the police department's certification program for private buildings, ultimately proposing improvements. A two—stage expert survey was conducted to gather opinions on the effectiveness and necessity of expanding the certification program and to discuss policy implications regarding physical environment factors for crime prevention.

In the first survey, experts provided feedback on the police department's crime prevention certification program. Fifty—three percent of respondents were positive about the program's awareness, though some pointed out a lack of awareness and insufficient promotion. Forty—one percent rated the program's operation positively, with many commenting that it was systematic and practical. However, concerns about inadequate recognition, effectiveness, and lack of incentives were raised. Sixty—eight percent evaluated the operation method positively, considering the on—site diagnosis and re—certification system appropriate, but issues such as insufficient information provision, lack of substantial benefits, and limited scope of certification targets were identified.

Regarding the checklist items and point allocation, 82% found it appropriate, but concerns about the lack of rationale for the point system, excessive item segmentation, and subjectivity were noted. Seventy-nine percent rated the crime prevention effectiveness positively, although the lack of specific validation data was mentioned. Regarding the need for expanding the certification program, 97% expressed positive views, believing that its expansion would improve crime prevention and enhance the physical environment of private buildings. Suggestions for expansion included providing incentives, enhancing promotion, offering legal support, linking with public facilities, strengthening research, and supporting professionals.

In the second survey, based on the analysis results of the impact of physical environment factors on crime, experts provided opinions on the policy implications. The positive correlation between population density and crime occurrence highlighted the need for more detailed analysis considering population characteristics (e.g., age, gender). Further research was also required to include social class and lifestyle patterns. Regarding land use, the tendency for higher crime rates in commercial and mixed-use areas was emphasized. Although green spaces showed a reduction in crime, concerns about hidden crimes due to visual obstructions in green spaces were raised. In road networks, narrower and darker roads were found to be more prone to crime, and expanding pedestrian pathways was seen as helpful for crime prevention. In terms of building forms, areas with higher building coverage ratios and floor area ratios had higher crime occurrences. Various factors, including building form, density, and age, were assessed to influence crime. The relationship between CCTV installation and crime occurrence revealed that CCTV was installed in high-risk areas and showed a positive correlation with crime. However, experts pointed out that the causal relationship is unclear and that increasing the number of CCTV cameras alone may not effectively prevent crime. A strategic approach considering the location, management, and regional characteristics of CCTV was recommended. Analysis of crime occurrence by building use revealed that crime is frequent around facilities with high public use, such as entertainment venues. Experts proposed specific policy improvements based on physical environment factor analysis, such as subdividing populations, reflecting regional characteristics, considering building age and size, and optimizing CCTV installation locations. They also suggested strengthening the expansion and

efficient operation of the certification program, providing incentive systems, and developing data–driven research to support better decision–making.

Chapter 5: Conclusion

This study aimed to advance crime prevention in architecture and urban physical environments, with a focus on enhancing the police department's crime prevention certification program for private buildings. It utilized statistical and machine learning analyses of crime occurrence and physical environment data to provide objective evidence and derived policy implications based on expert opinions. The study explored various methodologies for crime data analysis and applied multiple approaches to assess their applicability, with expectations to refine these techniques for more sophisticated crime prevention policies in future research.

The ways to advance crime prevention environmental design are as follows: First, social surveillance can deter crime, and to enhance this, it is essential to expand public spaces and resting areas while improving the safety of parks and green spaces through design. Second, CPTED standards should be established based on population characteristics. Third, areas with high building coverage and floor area ratios show a higher potential for crime, so applying CPTED standards by land use zone and offering incentives should be considered. Fourth, narrow roads may increase crime, necessitating interventions in such areas. Fifth, additional analyses should consider the relationship between building deterioration and narrow alleyways. Sixth, CCTV installation should focus on optimizing locations and establishing an efficient management system rather than merely increasing the number of cameras. Seventh, further analysis of crime patterns around popular public facilities is required. Eighth, a barrier–free living environment should be applied, and additional analysis should consider local income levels and population size. Empty houses or vacant buildings, which are highly correlated with crime occurrence, should also be included in the analysis. Ninth, the impact of physical environment factors on perceived crime insecurity should be analyzed, and based on this, policies for crime prevention environmental design should be set.

Proposals for improving the certification program are as follows: First, to raise awareness and increase participation, it is necessary to conduct broadcasts and systematic promotional campaigns, sharing certification cases and showcasing

the effectiveness of the program. Second, a broader target area should be considered for certification, encompassing not only private buildings but also public spaces, along with measures for building managers' responsibility. Third, clearer rationale should be provided for the certification program's checklist and point system. Fourth, the program should reflect local characteristics in the certification process. Fifth, the certification program should be expanded to include larger-scale buildings, with a focus on areas with high crime rates. Sixth, regional experts should participate in decision-making. Seventh, experts recommended that post-certification evaluations and monitoring be conducted periodically to ensure sustained effectiveness. Lastly, incentives should be provided to encourage private buildings to participate and maintain certification. The statistical and machine learning analysis techniques used in this study can serve as useful tools for gaining a deeper understanding of the relationship between Physical environment factors and crime occurrence. This study was in the exploratory stage of examining methodologies suitable for crime data analysis, applying and comparing various approaches. It is anticipated that future research will refine these analytical techniques to establish more sophisticated crime prevention policies.