Factors of a Surveillance Environment that Affect Burglaries in Commercial Districts

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Abstract

This study proposes a surveillance approach that will enhance safety in commercial districts. The authors identified physical factors that increase the likelihood of burglaries, and analyzed a commercial zone in relation to these factors to create a crime-free urban area. The study was conducted in Yeoksam-dong, a neighborhood of Gangnam-gu (the Gangnam District) in Seoul, Korea's capital. Yeoksam-dong has a large floating population. The authors found that: (1) In commercial districts, burglaries on footpaths accounted for most crimes, and illegal activities occurred in certain spaces. (2) In high crime-risk areas, views of the street from the first floor were relatively wider than those from the second floor. Night lighting was adequate, according to South Korean standards, but very uneven. (3) The surveillance environment used depended on road width (12 m was the baseline), since roads affect building size, and the installation criteria for streetlights were applied inconsistently. (4) The factors that affected burglaries in commercial zones were the street gradients (SG), the number of streetlights (STL), the viewing areas from the first floor (1F VA), and minimum levels of illumination (Min I). SG, STL, and Min I indicated a positive relationship with burglaries, while 1F VA showed a negative correlation.

Keywords: natural surveillance; mechanical surveillance; burglary; GIS (geographic information system)

1. Introduction

1.1 Background

Recently, crime has been considered the leading cause of social unrest in South Korea. According to the Supreme Prosecutor's Office (SPO), urban crime in general has been rising continuously in South Korea since the 1970s; the current figure is about 3.7 times what it was in the 1970s, and the types of offenses being committed are becoming more diversified (SPO, 2013). When the occurrence rates of the five most common crimes were examined, there were 290,841 burglaries, 126,520 assaults, 26,919 rapes, 4,021 robberies, and 1,221 murders (SPO, 2013). According to a 2012 Social Survey by Statistics Korea (KOSTAT), 3 out of 10 people (29.3%) feel that crime is the main reason for insecurity in South Korean society. Ongoing efforts are being made to create a safe environment, in order to solve this social problem.

The determinants of crime rates can be divided into human dimensions (psychological and physical elements, the pathological characteristics of criminals), and environmental dimensions (such as socioeconomic, demographic, and physical factors). However, from the perspective of prevention, human dimensions are difficult to address in advance, because doing so can violate individual rights. Hence, it may be more fruitful to focus first on environmental factors, and clarify their effects on crime. The physical environment is especially important, because it affects a broad spectrum of citizens equally, and the visible effects of lowering crime are maximized.

Crime has a geographic attribute. After examining the locations of offenses perpetrated in 2012, it was shown that the proportion of incidents that occurred adjacent to streets was quite large at 42.8%, followed by 5.5% at streets next to detached houses, 5.1% at entertainment centers, and 3.5% at stores (SPO, 2013). However, it is not easy to apply crime prevention techniques such as controlling access and activities in open spaces; urban street environments are one example. It is especially difficult to strengthen crime prevention efforts on footpaths in commercial districts used by the general public. An alternative to this approach is implementing sociological crime prevention concepts such as the "eyes on the street," coined by Jacobs (1961). Recently, the use...
of mechanical surveillance devices, such as CCTVs (closed-circuit televisions), has increased, and these methods are being promoted aggressively to prevent illegal activities. It is therefore necessary to work toward thwarting crime by focusing countermeasures on busy walking spaces in commercial districts.

1.2 Objectives

This study proposes a surveillance approach that will reduce crime and increase safety in commercial districts. The authors identified physical factors that influence the number of burglaries perpetrated, and selected a commercial district in which to create an urban area safe from crime.

2. Literature Review

2.1 The Meaning of Surveillance

As can be seen from the word's origin ("sur," meaning "over," and "veil," meaning "see"), surveillance is the act of viewing with specific desires beyond simply seeing. Lyon (2003) stated that surveillance is the monitoring of people's behaviors or activities in order to protect, control, and instruct them. Foucault argued in *Discipline and Punish* (1977) that surveillance was based on the concept of the "panopticon," and that discipline was achieved in modern society through surveillance. J. Bentham published a book on his designs for a Panopticon prison in 1791, in which prisoners' rooms circled a central watchtower from where they were monitored. In this schema, the potential for being observed was as important as actually being observed.

Surveillance thus combines social controls, disciplinary power, and modern technologies. Used as a tool for control (Foucault, 1977; Cohen, 1985) for specific purposes in modern times, the scope of its application has been gradually expanded. As Lyon (2001) argued, surveillance always has positive and negative aspects simultaneously. In modern society, there is a tendency to respect the privacy of individuals; thus, the negative aspects of surveillance have been emphasized. Nevertheless, surveillance has become increasingly convenient to implement, and has come to constrain all aspects of everyday life (Goffman, 2009). Thus, recent research has resisted surveillance, whether consciously or unconsciously (Gilliom, 2001).

2.2 Crime and Surveillance

Surveillance does not necessarily yield positive results. However, with the increasing complexity of modern society, surveillance has been recognized as useful for preventing crimes and facilitating the arrest of criminals. To explain the importance of surveillance in regard to crime prevention, Jacobs' concept of "eyes on the street" may be used as a starting point. Jacobs argued that natural surveillance by pedestrians is an effective means for preventing the occurrence of crime in cities. Newman (1972) found that physical environments providing residents and managers with the opportunity to surveil each other could facilitate natural surveillance. By designing windows and doors to facilitate mutual surveillance, Newman argued that visibility could be enhanced. Thus, it has been argued that surveillance is a crucial aspect of designing physical environments oriented toward crime prevention. In the design context, Crowe (2000) argued that surveillance could prevent trespassing. In particular, he argued that surveillance could control access to spaces by increasing the offender's risk of exposure.

Consistent with Jacobs' ideas, Desyllas et al. (2003) wrote that natural surveillance cannot be achieved by policy directives, but is instead a by-product of community activities. In other words, surveillance does not inhere in police patrols and other administrative acts, but in the daily routines of the general public. Moreover, Bottoms and Wiles (1997) argued that surveillance by pedestrians can reduce vehicular and residential burglaries. Furthermore, although natural surveillance has the same limits as human vision, continuous technological development has enabled mechanical surveillance to be conducted in various places, for example, by CCTV.

Ongoing empirical research on surveillance of criminal activities has clarified the relationship between surveillance and crime from various points of view. Desyllas et al. (2003) evaluated natural surveillance by analyzing fields of visibility from the gates of buildings. Their study indicated that the traditional street network facilitated more effective surveillance compared with that afforded by a planned college campus; they suggested that natural surveillance is essential to reducing risk. Park and Shin (2006) aimed to clarify the correlation between the number of windows and doors on residential facades and the incidence of criminal activities. Their findings suggested that designing windows and doors with large dimensions can lead to a reduction in the occurrence of crime. Kim and Park (2010) have emphasized that CCTV systems must be installed in appropriate locations, and that a system for evaluating crime prevention using CCTV must be established.

This study classifies the surveillance environment into elements of "natural surveillance" and "mechanical surveillance." Based on this categorization, the authors analyze how these aspects are linked to criminal activities in commercial districts. In this way, the authors investigate the determinants of a surveillance environment that relate to the spatial features of crimes.

3. Methodology

This research was conducted in the following four stages: (1) By focusing on Seoul's 25 administrative districts, a target area was chosen, and the number of burglaries that had occurred was examined. The authors compared the proportions of floating populations to the areal sizes of commercial districts.
in the five administrative districts with the largest populations. Gangnam-gu was selected as the target area, as it was found to be the most suitable site for this study (Table 1.). (2) After documenting the locations of the burglaries in the target area, the data was converted into geographic coordinates. (3) Field surveys were conducted to gather data on the footpaths where many crimes have occurred, and the results were converted into geographic coordinates. (4) Using a GIS tool (Arcgis 10.0) and SPSS 21.0, the data were used to analyze the relationships between burglaries and the surveillance environment.

3.1 Target Area Selection

To select a study site, the five administrative districts with the highest number of burglaries in 2013 were identified. Next, Seoul's floating population survey data for each of the five administrative districts, and the areal extent of the commercial zones in each administrative district were tabulated. Based on this comparative analysis, Gangnam-gu ranked highest for the number of burglaries, and second highest for the size of the floating population and areal extent, and was chosen as the study's target area (Table 1.).

Gangnam-gu consists of 22 administrative sub-districts (neighborhoods called dong). Most commercial districts in Gangnam-gu are concentrated in Yeoksam-dong and Samsung-dong. The thoroughfare of Gangnam-daero, which connects Shinnonhyeon Station and Gangnam Station, is an area with a large floating population. Hence, Yeoksam-dong, which includes the above areas, was chosen as the target zone (Fig.1.).

3.2 Research Subjects

The data used for analysis are statistics documenting burglaries in 2012 in the target area, and numerical descriptions of the physical environment that were collected from cooperative relevant organizations. To assess the physical environment, the authors used metrics from a previous study (which also examined the physical environment), and classified them into two kinds of surveillance: natural and mechanical. The metrics that corresponded to each type of surveillance were selected and used as investigative tools (Table 2.).

3.3 Field Survey Methods

Staff conducted (1) the Viewing Area (VA) Survey, (2) the Illumination Survey, and (3) the Personal CCTV Survey. The criteria described next were used to select the most appropriate VA and Illumination Surveys.

3.3.1 Viewing Area (VA) Survey Criteria

The VA survey was used as a metric of national surveillance (NS). For the VA survey, the viewing areas of windows facing a road were investigated. To limit the viewing area's range, only the central- and near-field vision were targeted, as these are the areas in which a human can acquire accurate visual information. A horizontal plane with a visible angle of up to 30 degrees in a downward direction was established as the VA. The number of floors (from which it is possible to monitor pedestrians on roads) was estimated based on a measurement of 12 m, which is the maximum width of a footpath (Stein and Revnolds, 2000). Hence, in multi-floor buildings, the authors only surveyed the VA up to the second floor (Fig.2.).

3.3.2 Illumination Survey Criteria

The levels of illumination on footpaths in the target area were quantified using a method developed by the Korean Standards Association (KSA) (KSA, 2007). The authors established the following illumination survey criteria: (1) A total of 3 reference lines, including the centerline, were documented for each footpath. Based on the centerline, survey reference lines were drawn with about 1 m spacing on either side. (2) Illumination survey positions were established at

Table 1. Number of Burglaries, Size of the Floating Population, and the Areal Extent of Commercial Districts

| District (Gu) | No. of Burglaries | Floating Population | Areal Extent of Commercial Districts |
|---------------|-------------------|---------------------|--------------------------------------|
| Seodaemun     | 4,134             | 5,718               | 205,650                              |
| Yeongdeungpo  | 3,198             | 4,565               | 2,447,002                            |
| Gwanak        | 3,645             | 6,314               | 350,000                              |
| Gangnam       | 4,456             | 5,962               | 2,320,955                            |
| Songpa        | 3,905             | 3,993               | 2,159,719                            |

Fig.1. Commercial District Distribution in Yeoksam-dong

Fig.2. Viewing Area Survey Criteria
less than 3 m from the survey reference line. However, when the footpath was less than 2 m wide, the authors used the footpath’s centerline (Fig. 3.). (3) The height of illumination was estimated based on the height of the vertical plane of illumination at 1.5 m, which is comparable to a human’s eye level. (4) The authors carried out the illumination survey from 19:00 to 23:00 (i.e., roughly during sunset) because the streetlights are turned on after the sun goes down, businesses in non-residential buildings (commercial and neighborhood living facilities) close, and the illumination of footpaths changes, after 23:00. The authors used TEX Electrical Electronic’s TES-1335 as the tool.

4. Results

4.1 Burglary Rates in Commercial Districts in Yeoksam-dong

In Yeoksam-dong, 2,162 burglaries occurred in 2012: 1,842 street incidents (85.20%), and 320 break-ins (24.80%). There were only 630 occurrences (29.14% of all burglaries) in commercial districts. Of these, 599 burglaries (95.08%) took place on the streets. Most burglaries in commercial districts take place outside, in places people are passing through. A density analysis of crime rates (see Fig. 4.) and hotspots for illegal activity found that many incidents happened around subway stations (A and B). In Seoul, subways are the main means of public transportation. Most burglaries occurred in area C, which has the largest floating population (according to the 2012 Seoul floating population survey); one can always see complex flows of people in this zone. Also, spatial autocorrelation analysis (see Fig. 4.) was performed to confirm the statistical significance for the clustering of crime incidents, and the results yielded a Moran’s I Index of 1.495218, a z-score of 27.630345, and a p-value of 0.000000. Hence, it was confirmed that burglaries in the commercial districts centered in particular spaces.

4.2 Analysis of the Surveillance Environment in Crime Risk Areas

The authors analyzed the places where burglaries frequently occur, and documented how the environment in the surveillance area affected crime rates. Footpaths where burglaries had occurred at least three times were classified as crime risk areas, and the authors then analyzed these places further. Among the footpaths in the targeted zone, burglaries had occurred at least three times in 64 places (Fig. 5.). The frequencies ranged from a minimum of three times to a maximum of 70.

The authors conducted field surveys and data research to evaluate the physical environment of the crime risk areas shown above (also see Table 3. below). With respect to the average VA, 1F VA (33.61 m²) was relatively wide compared to 2F VA (30.62 m²), because the buildings in commercial districts are mainly used for sales, convenience stores, and business facilities. These facilities have facades that improve their visibility, so pedestrians can identify them easily. The buildings along Yeoksam-dong's main road are high-rises, which in many cases have glass as an exterior material. The average survey results for SS were 90.34 m SL, 20.13 m SLT.
The authors found that the deviations of maximum and minimum values were very large for SL and SW, because the footpaths along secondary roads were quite irregular, compared to the footpaths along the sides of main roads. Also, because most buildings have large underground and outside parking lots, there was no need to install a separate RPL.

Regarding the survey results for L, the footpath’s Max I was 100.45 lx, and the Min I was 8.31 lx, with a Mean I of 32.61 lx. Considering that the KSA’s illumination criteria for footpaths in commercial districts is 30–100 lx, the authors determined that the average and maximum amounts of illumination provided were acceptable, but that the minimum illumination levels were lower than allowed by the criteria. The average URI was 0.09, and the average SLT was 2.36. Lastly, as a survey result for CCTV, DPC was shown to be 97.93 m, and NPC was 0.73. With respect to the DPC, because the CCTVs operated by public organizations were installed mainly for the purpose of monitoring the residential areas inside blocks, the distances to the target footpaths located on the outskirts of blocks were relatively long.

Currently, a total of 121 public CCTVs are operating in Yeoksam-dong; among these, only 12 units are installed in the commercial districts. The private CCTVs, which are less than 1 unit per footpath, are mostly of a fixed type; to a limited extent, they can only monitor the entrances of relevant buildings or the driveways of outdoor parking lots.

### 4.3 Analysis of the Surveillance Environment in Crime Risk Areas

Analysis of the crime risk areas indicates that footpaths that are 12 m wide have distinctive characteristics. Roads less than 12 m wide (SW-1) do not separate the sidewalk and vehicular pathways, and vehicles and pedestrians share lanes. However, for roads at least 12 m wide (SW-2), the vehicular pathway and the sidewalk are separated for reasons of pedestrian safety, and passage on foot is only possible via the footpaths. After assessing the burglaries that occurred on footpaths that the study had classified (Table 4.), the authors found that 367 (58.25%) burglaries occurred in SW-1, and 263 (41.75%) occurred in SW-2. Among these, 31 were break-ins, and of these, 30 (96.77% of the total) took place in SW-1. The t-test confirmed that IB occurred more often in SW-1 than in SW-2 ($p < .01$) (Table 5.).

### Table 3. Averages of Surveillance Environment Variables for Crime Risk Areas

|        | Min | Max | Mean | SD  |
|--------|-----|-----|------|-----|
| NS VA  | 0.00| 113.40 | 33.61| 29.54|
| 1F VA  | 0.00| 104.64 | 30.62| 25.11|
| 2F VA  | 0.00| 2.30  | 0.48 | 0.45 |
| 1F VAR | 0.00| 1.52  | 0.41 | 0.35 |
| 2F VAR | 0.00| 1.52  | 0.41 | 0.35 |
| SS SL  | 27.59| 188.96 | 90.34| 45.13|
| SW     | 4.00 | 50.00  | 20.13| 19.82|
| RPL    | 0.00 | 4.00   | 0.36 | 0.91 |
| SG     | 0.00 | 9.21   | 1.89 | 2.52 |
| Co     | 2.00 | 6.00   | 4.42 | 0.85 |

### Table 4. Burglary Rates According to Road Type

|        | IB  | SB  | IB  |
|--------|-----|-----|-----|
| F      | %   | F   | %   |
| SW-1   | 367 | 58.25 | 337 | 56.26 | 30 | 96.77 |
| SW-2   | 263 | 41.75 | 262 | 43.74 | 1  | 3.23 |
| total  | 630 | 100.00 | 599 | 100.00 | 31 | 100.00 |
4.4 Analysis of the Effects of the Surveillance Environment on Burglaries in Commercial Districts

A multiple regression analysis was conducted to analyze how the physical environment affected burglaries in crime risk areas in commercial districts. TB was used as a dependent variable, and the surveillance variables (belonging to NS and MS) were used as independent variables. The authors performed this analysis using a stepwise selection method to input the independent variables. Four models were extracted, and the model with the highest explanatory power was selected. In the selected regression model, 4 surveillance variables (SG, SLT, 1F VA, Min I) were shown to influence burglary rates. Hence, the surveillance environment variables included in the model explain 24.9% (adjusted $R^2$: 19.8%) of burglaries in crime risk areas in commercial districts. Due to variance analysis for the 4 surveillance environment variables, the $F$ value was 4.896, and Sig. was 0.002 ($p < .01$). The analyzed regression analysis is statistically significant (Table 7.).

Table 7. Regression Model Variance Analysis of Factors that Affect Burglaries in Commercial Districts

| Model | Sum of Squares | df | Mean Square | F   | Sig.   |
|-------|----------------|----|-------------|-----|--------|
| Regression | 2815.906 | 4 | 703.976   | 4.896  | .002*  |
| Residual   | 8482.532 | 59 | 143.772  |       |        |
| Total      | 11298.438 | 63 |            |       |        |

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 5. Assessment of Burglary Rates by Road Type

| Road Type | SW N Mean Sd df t |
|-----------|-----------------|
| SB        | SW-1 41 8.22 13.64 62 -0.893 |
| SB        | SW-2 23 11.39 13.60 |
| IB        | SW-1 41 8.95 13.37 62 -0.709 |
| IB        | SW-2 23 11.43 13.57 |

Table 6. Assessment of Surveillance Environment Factors According to Road Type

| Road Type | SW N Mean Sd df t |
|-----------|-----------------|
| NS VA     | SW-1 41 27.14 23.78 62 3.369 2.179*** |
| NS VA     | SW-2 23 45.14 35.41 |
| 2F VA     | SW-1 41 30.86 23.59 62 0.103 |
| 2F VA     | SW-2 23 30.19 28.16 |
| 1F VAR    | SW-1 41 0.49 0.50 62 0.268 |
| 1F VAR    | SW-2 23 0.46 0.35 |
| SS SL     | SW-1 41 76.25 40.44 62 -3.646*** |
| SS SL     | SW-2 23 115.46 42.77 |
| RPL       | SW-1 41 0.54 1.10 | 44.973 2.788** |
| RPL       | SW-2 23 0.04 0.21 |
| SG        | SW-1 41 2.32 2.78 | 60.813 2.093* |
| SG        | SW-2 23 1.13 1.78 |
| Co        | SW-1 41 4.34 0.96 | 62 -1.01 |
| Co        | SW-2 23 4.57 0.59 |
| MS L      | Max I SW-1 41 103.93 116.65 62 0.364 |
| MS L      | SW-2 23 94.24 68.37 |
| Min I     | SW-1 41 9.42 12.63 | 54.784 1.425 |
| Min I     | SW-2 23 6.32 4.45 |
| Mean I    | SW-1 41 34.40 33.90 | 54.784 0.817 |
| Mean I    | SW-2 23 29.41 14.51 |
| URI       | SW-1 41 0.10 0.12 | 61.555 0.509 |
| URI       | SW-2 23 0.08 0.06 |
| SLT       | SW-1 41 0.49 1.43 | 25.844 -6.546*** |
| SLT       | SW-2 23 5.37 3.66 |
| CCTV DPC  | SW-1 41 80.73 62.97 62 -3.027*** |
| CCTV DPC  | SW-2 23 128.59 56.27 |
| NPC       | SW-1 41 0.80 1.35 62 0.56 |
| NPC       | SW-2 23 0.61 1.34 |

* $p < .05$, ** $p < .01$, *** $p < .001$

To see whether a statistical difference exists in the survey variables according to the traits (SW-1 and SW-2) of footpaths, a t-test was conducted for the surveillance environment metrics (Table 6.). This analysis showed significant differences according to the features of footpaths in 1F VA, SL, RPL, SG, SLT, and DPC.

The differences among 1F VA, SL, and RPL can be attributed to building configurations in commercial districts. That is, the lower levels of large buildings in commercial districts (such as office buildings and other commercial buildings) have relatively higher visibility than upper levels, because they have main entrances and display windows along the road. In addition, there is no need for separate parking spaces, because they are not residential buildings.

Furthermore, the differences between SLT and DPC can be seen as an outcome of urban planning standards. In other words, the streetlights are installed leaving a certain gap (50 m) on the sides of the main road, and are partially installed on the secondary roads in places where security is required. That is why relatively more streetlights were installed in SW-2, where main roads are usually located. However, the illumination-related variables (Max I, Min I, Mean I) were higher in SW-1, which had fewer streetlights. Hence, it is possible to conclude that the major factors related to footpaths in commercial zones were not determined by streetlights, but rather by the signage installed on buildings, or illumination projected from inside the buildings to the outside. When a public CCTV is installed, priority is given to the residential area inside a block, as explained earlier.

Table 8. Summary of Regression Analysis

| Coefficient | Standard Error | t | Sig. |
|-------------|----------------|---|------|
| Intercept   | 5.70           | 3.66  | 1.57  |
| Max I       | 0.49           | 1.43  | 0.35  |
| SLT         | 0.49           | 1.43  | 0.35  |
| CCTV DPC    | 0.49           | 1.43  | 0.35  |
| NPC         | 0.49           | 1.43  | 0.35  |

* $p < .05$, ** $p < .01$, *** $p < .001$
When the gradient of a footpath rises, because pedestrians focus more on walking compared to when they are traversing flat land, visibility is relatively constrained. Hence, an environment is created that is suitable for a potential criminal act. One can analyze it from the angle of an increase in the opportunity factor (Meithe and Meier, 1994). Secondly, it is necessary to consider the characteristics of an area when hypothesizing that burglaries increase with increases in STL and Min I. Many studies show that, in general, crime rates fall when illumination improves visibility (Tien et al., 1979).

However, in this study, the results show that burglary rises when the illumination of an environment improves; this result is deeply connected to the floating population. In other words, because most people using the commercial districts are random, unknown individuals visiting for specific purposes, and are not residents of the areas, they usually use spaces favorable for walking. Hence, one can posit that burglary also rises in spaces that are brightly lit at night, and so relatively conducive to walking.

An increase in 1F VA helps reduce burglaries because human surveillance improves on the ground-floor-level of a footpath, and criminal acts can be prevented. This means that even if direct surveillance is not used, the number of crimes committed can be reduced when the area is monitored. This scenario is analogous to the concept of the "panopticon" model.

Table 8. Results of the Regression Analysis of Factors Affecting Burglaries in Commercial Districts

| Model       | UC      | SC      | t      | Sig. | CS |
|-------------|---------|---------|--------|------|----|
| (Constant)  | 6.275   | 3.152   | 1.991  | 0.051|    |
| STL         | 1.416   | 0.63    | 2.249  | 0.028| 0.908| 1.101|
| SG          | 1.402   | 0.454   | 3.086  | 0.003| 0.896| 1.115|
| 1F VA       | -0.152  | 0.056   | -2.691 | 0.009| 0.82 | 1.219|
| Min I       | 0.324   | 0.16    | 2.029  | 0.047| 0.811| 1.233|

UC : Unstandardized Coefficients  
SC : Standardized Coefficients  
CS : Collinearity Statistics  
5. Discussion

Surveillance is perceived as being a useful tool for preventing crimes, or apprehending criminals after a crime has been committed. In particular, because the types and patterns of crimes are becoming more diverse in modern society, the types of surveillance used are subcategorized into natural surveillance, mechanical surveillance, and organized surveillance, in order to cope with the situation (Crowe, 2000). Accordingly, the present study classified the surveillance environment factors into natural surveillance factors and mechanical surveillance factors, and examined the subfactors of each category, in order to analyze the physical environmental factors that affect burglary in commercial districts.

The authors found that even in the same commercial district, crimes are concentrated in certain areas. This observation is consistent with the results of previous studies (Brantingham and Brantingham, 1981). Criminal activities are centered around multi-use facilities, such as the nodal points of public transport (subway stations), where the floating population tends to be large, or movie theaters, where the floating population has a big inducing effect. Lee and Ha (2015) argued that outdoor spaces where people can congregate have the potential to be crime hotspots, despite the environmental condition of high visibility. Hence, by continuously tracking the flow of the floating population, and informing the general public of this sector's movements, people can prepare to confront crime at the individual level.

The physical surveillance factors that affected burglary rates in commercial districts (See Table 2.) were the street gradient (SG), the number of streetlights (STL), the first floor viewing area (1F VA), and the level of illumination (Min I) (Fig.6.).

Fig.6. Surveillance Environment Variables Affecting Burglary Rates in Commercial Districts

In order to reduce and prevent crimes using these elements, it is necessary to first examine whether they align with the district's purpose, and how easy it is to control individual environmental factors. In other words, the purpose of designating commercial districts is to promote consumption, by encouraging the participation of potential consumers who are part of the floating population. The gradients of footpaths among the four factors are not easy to change in existing commercial areas, due to the structural features of roads. Therefore, to reduce the incidence of burglaries in commercial districts using environmental factors, improving the visibility and lighting environment should be considered first. Above all, the visibility at lower levels, including first floors, needs to be secured to improve burglary surveillance on walkways. Previous studies also suggested this as a measure for crime prevention. For this to happen, it is necessary to continually reinforce, manage, and supervise zoning regulations to ensure that signage does not hinder visibility from the lower levels of buildings in commercial districts. Unlike previous studies, this study found that improving lighting conditions (STL, Min I) has a positive relationship with crime occurrence. However, installing fewer street lights and reducing the minimum levels of illumination to
reduce crime may be counter to vitalizing commercial districts. Therefore, it is imperative to offset the risk of crimes (by installing more public CCTVs, for example) where there is an increased floating population, while improving overall lighting conditions (such as illumination and uniformity) for the convenience of local users.

This study is limited because the authors examined methods for reducing limited types of crime (i.e., burglaries), and considered only some aspects of the physical environment. Furthermore, one cannot generalize the findings of this study to all commercial districts, because the authors targeted a specific area. However, the authors have determined that, based on the results of this study, in the future it will be possible to research commercial zones in different socioeconomic contexts. As a result, it is expected that safer and more vibrant walking environments will be built.

Acknowledgement

This work was supported in part by the Yonsei University Research Fund of 2014, and the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2014S1A5A2A01013850).

Notes
1. 2013 Crime Analysis (http://www.spo.go.kr)
2. The 2012 Seoul floating population survey results (http://opengov.seoul.go.kr)
3. 2012 Use of a District by the Administrative District (http://kosis.kr)
4. Reference no: 4), 12), 13), 14), 15), 21)
5. In South Korea, if a road is wider than 12 m, sidewalks and vehicular pathways are installed separately. When a road is less than 12 m in width, footpaths and vehicular pathways are not separated. Hence, in this study, the maximum width of a footpath was set as 12 m.
6. Data were acquired from the Seoul Metropolitan Police Agency and the Gangnam Police Station.
7. A 1:5000 digital map created by the National Geographic Information Institute was used.
8. https://kn.park119.net:444/user/index.aspx
9. http://gis.seoul.go.kr/
10. Acquired by requesting information from the Gangnam-gu Office.

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