The crime-reduction effects of open-street CCTV in South Korea

Article *in* Security Journal · April 2013

DOI: 10.1057/sj.2013.10

Original Article

The crime-reduction effects of open-street CCTV in South Korea

Hyungjin Lim[a,*], Changjoo Kim[b], John E. Eck[a] and Jeonglim Kim[c]
[a]School of Criminal Justice, University of Cincinnati, 665 Dyer Hall, Clifton Avenue, PO Box 210389, OH 45221-0389, USA.
E-mail: limhi@mail.uc.edu
[b]Department of Geography, University of Cincinnati, 400B Braunstein Hall, Cincinnati, OH 45221-0131, USA.
E-mail: changjoo.kim@uc.edu
[c]Department of Sociology and Criminal Justice, Briar Cliff University, 3303 Rebecca Street, Sioux City, IA 51104, USA.
E-mail: jeonglim.kim@briarcliff.edusu.edu

*Corresponding author.

Abstract This research examines the crime prevention effects of open-street closed circuit televisions (CCTVs), installed in the city of Chuncheon, South Korea on serious crimes and disorder crimes. After controlling for the length of the month, season and temporal trend, we applied a mixed linear model for repeated measurements. We also used a Weighted Displacement Quotient (WDQ) to analyze the crime-reduction effects of each open-street CCTV location. The results of a mixed linear model showed that, on average, open-street CCTV did not show a statistically significant effect on the reduction of serious crimes or disorder crimes. However, the analysis of a WDQ showed that the crime-reduction effect of open-street CCTV location depends on the characteristics of the locations. The results also showed that the effects of a diffusion of benefits were higher in serious crimes than in disorder crimes. Results are similar to findings in European and North-American contexts.
Security Journal (2016) **29,** 241–255. doi:10.1057/sj.2013.10; published online 22 April 2013

Keywords: crime; mixed linear model; open-street CCTV; repeated measures; WDQ; crime prevention

Introduction

Police and local governments operate open-street closed circuit television (CCTV) systems to prevent crime (Wilson and Sutton, 2003). It has been installed in many countries, across private and public settings, and has been the subject of considerable research (Norris and Armstrong, 1999; Webster, 2004; Gill, 2006; Ratcliffe, 2006; La Vigne *et al*, 2011a).

Since the 1990s, researchers have studied the various effects of open-street CCTV. Although there is research on the relationship between open-street CCTVs and feelings of safety (Wilson and Sutton, 2003; Williams and Ahmed, 2009), as well as between open-street CCTV and guardianship (Surette, 2006), most of the research describes its crime-reduction effects (Phillips, 1999; Sivarajasingam and Shepherd, 1999; Welsh and Farrington, 2002, 2003, 2004, 2009; Gill and Spriggs, 2005; Farrington *et al*, 2007; Ratcliffe *et al*, 2009; Caplan *et al*, 2011; La Vigne *et al*, 2011b). Recently, meta-analyses of the crime-reduction effects of open-street CCTV have indicated that open-street CCTV can be an effective way of reducing crime. However, it is far from a universally useful tool against crime in the street (Phillips, 1999; Welsh and Farrington, 2002, 2004, 2009; Gill and Spriggs, 2005; Farrington *et al*, 2007).

Despite this research, there are several important gaps in our knowledge. Most of the research was conducted in Western countries, such as the United Kingdom and the United States. As a result, we do not know whether open-street CCTV works well in non-Western countries. Second, several meta-analytic studies found that CCTV influences crime differently depending on the characteristics of locations (Welsh and Farrington, 2002, 2009; Gill and Spriggs, 2005; Farrington *et al*, 2007). However, there is little research comparing the relative effectiveness of CCTV sites within the same jurisdiction.

This article seeks to help fill these two gaps. First, this article examines the crime-reduction effects of open-street CCTV in South Korea, one of the Asian countries in which the number of open-street CCTVs has rapidly increased in recent years. Second, this article directly examines the relationship between local settings and the effectiveness of open-street CCTV at reducing crime and disorder.

We organized this study as follows. The next section briefly reviews the CCTV effectiveness literature. The subsequent section discusses the methods we used in our study: research hypotheses, sample of CCTV sites and the analytical models used. The section after that analyzes the results. The final section provides a discussion of the implications of our study in the context of the earlier research.

Research

There have been numerous studies on the crime-reduction effects of CCTV since its advent. These have been reviewed in several meta-analyses (Phillips, 1999; Welsh and Farrington, 2002, 2003, 2004, 2009; Gill and Spriggs, 2005; Farrington *et al*, 2007).

As shown in Table 1, research on crime-reduction effects of CCTV shows mixed results. The previous studies found that the effectiveness of CCTV varied by the context within which it was applied. Research reported that CCTVs in car parks significantly affected crime reduction; however, CCTVs in city centers and residential areas did not influence crime reduction as much (Sivarajasingam and Shepherd, 1999; Welsh and Farrington, 2002, 2003, 2004, 2009; Gill and Spriggs, 2005; Farrington *et al*, 2007). Another salient finding of the previous research is that the effects of CCTV depend on the type of crime. Research shows that CCTV has a significant effect on property crime and disorder crime, whereas it does not have a significant effect on violent crime and serious crime (Philips, 1999; Sivarajasingam and Shepherd, 1999; Welsh and Farrington, 2002, 2003, 2004; Ratcliffe *et al*, 2009; Caplan *et al*, 2011).

Research also shows that CCTV effectiveness varies by city. La Vigne *et al* (2011b) evaluated the impact of open-street CCTV implementation on crime in three US cities: Baltimore, Maryland; Chicago, Illinois; and Washington DC. Their evaluation produced mixed results. In Baltimore, it confirmed promising findings in three of the four camera areas with a significant decrease in both property and violent crimes without displacement;

Table 1: Summary of CCTV research on crime reduction

Study	*Country*	*Method*	*Findings*
Caplan *et al* (2011)	United States	ANOVA analysis, Pre/post *t*-test, Location Quotient test	Shooting: N Auto theft: S Thefts from auto: N
La Vigne *et al* (2011b)	United States	Time series and difference-in-differences analyses, WDQ (three metropolitan cities)	Mixed results depending on cities
Ratcliffe *et al* (2009)	United States	Mixed linear model for repeated measurements analysis, WDQ	Serious crime: N Disorder crime: S All crimes: S
Welsh and Farrington (2009)	United Kingdom, United States, Canada, Sweden, Norway	Meta-analysis (44 evaluations)	City and town center: N Public housing: N Public transportation: N Car parks: S
Farrington *et al* (2007)	United Kingdom	Meta-analysis	Train station car parks: S City center: N Residential area: N
Welsh and Farrington (2004)	United Kingdom, United States	Meta-analysis (19 evaluations)	City center: N Public housing: N Car parks: S Public transportation: N Property crime: S Violent crime: N
Gill and Spriggs (2005)	United Kingdom	Meta-analysis (13 evaluations)	Car parks: S Residential area: N
Welsh and Farrington (2003)	United Kingdom, United States	Meta-analysis (22 evaluations)	City center: N Public housing: N Public transportation: N Car parks: S Vehicle crime: S Violent crime: N
Welsh and Farrington (2002)	United Kingdom	Meta-analysis (22 evaluations)	City center: N Public transportation: N Car parks: S Vehicle crime: S Violent crime: N
Phillips (1999)	United Kingdom	Meta-analysis (27 evaluations)	Property crime: S (in certain settings) Personal crime, public order, fear of crime:?
Sivarajasingam and Shepherd (1999)	United Kingdom	Comparison between before and after CCTV installation	City center: N Violent crime: N

N – Non-significant reduction; S – Significant reduction; ? – Uncertain.

however, no crime reduction was found in one of the areas. In Chicago, whereas one area indicated a significant reduction in total crime with diffusion of benefit but without displacement, the other area showed more prostitution but less robbery following camera deployment. Finally, in Washington DC, after controlling for potential confounding variables, no significant change in crime appeared.

In terms of the displacement effect of open-street CCTV, research shows that spatial displacement is not a common side effect of CCTV use (Short and Ditton, 1998; Ratcliffe *et al*, 2009; Waples *et al*, 2009; Caplan *et al*, 2011; La Vigne *et al*, 2011b). However, research indicates that spatial displacement depends on the locations of open-street CCTV and the type of crime (Ratcliffe *et al*, 2009; Waples *et al*, 2009; Caplan *et al*, 2011). For example, Ratcliffe *et al* (2009) showed that displacement of open-street CCTVs varies among CCTV locations. Caplan *et al* (2011) found that open-street CCTV had a significant displacement effect in auto theft, whereas it did not have much of a displacement effect in shootings and thefts from vehicles.

To summarize, although there is evidence that open-street CCTV can reduce crime, its effectiveness varies considerably. Consequently, it is critical to examine CCTV in many very different contexts. Here, we examine its effectiveness in multiple settings within a South Korean city.

Methods

Research hypotheses

This research examines three hypotheses to explore open-street CCTV crime-reduction effects in South Korea. The first hypothesis is that open-street CCTV decreases serious crime. The second hypothesis is that open-street CCTV decreases disorder crime. The third hypothesis is that the effectiveness of open-street CCTV in crime reduction varies by the setting of the camera. For this research, the concept of serious crimes follows South Korean Police criteria: homicide (including homicide attempt, robbery-homicide and manslaughter), robbery (including robbery-assault and robbery-rape), rape, theft (including burglary), assault, arson and drug offenses. All other crimes are designated as disorder crimes. The South Korean Police criteria differ slightly from Ratcliffe *et al*'s (2009) definitions of serious crime (Uniform Crime Reporting (UCR) Part 1 street offenses) and disorder crime (UCR Part 2 street offenses), which will be explained. The dependent variables included serious crime and disorder crime. Serious crime was defined as the number of serious crimes per month in each location and, as mentioned earlier, we followed the South Korean Police criteria on serious crimes. Similarly, disorder crime was defined as the number of any other crimes per month in each location. Table 2 presents the descriptive statistics for the variables.

Sample

For this research, we selected the Chuncheon City Police Station in South Korea. Chuncheon is a middle-sized city with a population of approximately 270 000 people. The police station

Table 2: Descriptive statistics ($N = 432$)

Variables	*Mean*	*SD*	*Minimum*	*Maximum*
Dependent				
Serious crime	0.30	0.63	0	3
Disorder crime	0.50	0.97	0	7
Independent				
Length of month	30.44	0.82	28	31
Temporal trend	24.50	13.87	1	48
Seasonal effect	53.04	17.59	24	79
Camera	0.43	0.50	0	1

  0955-1662 **Security Journal** Vol. 29, 2, 241–255

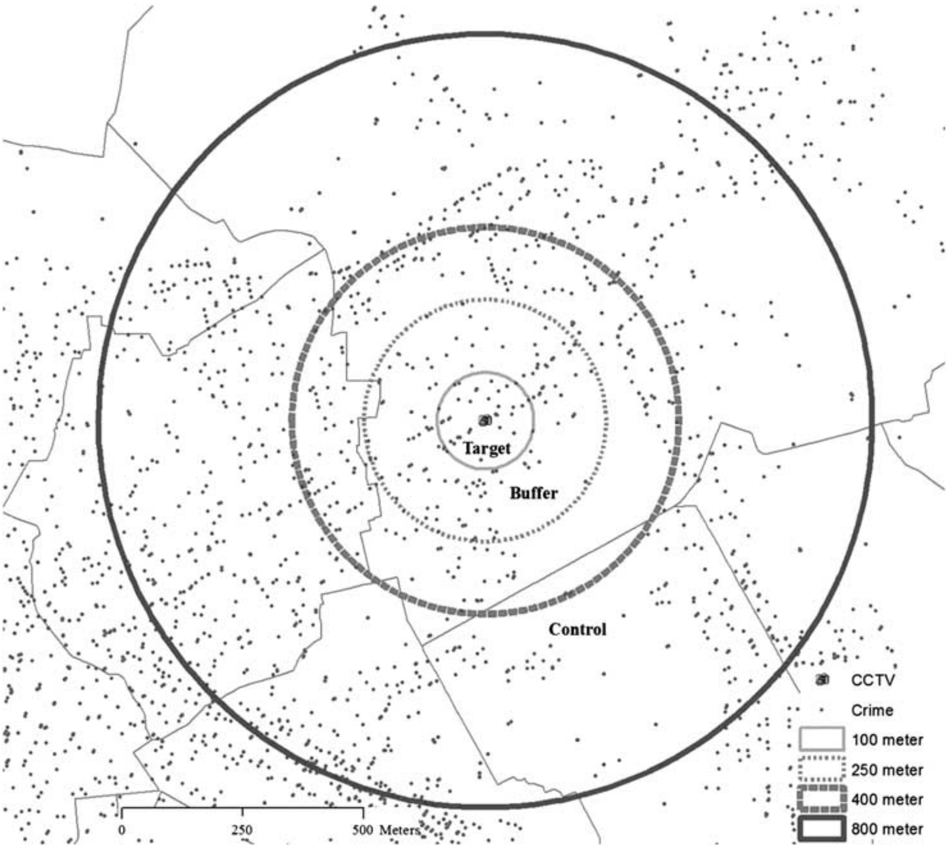

Figure 1: Target, buffer and control areas (#9).

was selected because of the number of open-street CCTVs and the number of crimes in the territorial jurisdiction of the police station. The police station introduced open-street CCTV in 2007 to prevent crimes and deployed 59 open-street CCTVs in 20 locations before 2009. Our research examined all the reported crime incidents within the Chuncheon City Police Station jurisdiction from 2006 through 2009.

Following standard practice, we designated a target area, control area and buffer area for each CCTV (Farrington *et al*, 2007; Ratcliffe *et al*, 2009). There are two methods for deciding target areas (Ratcliffe *et al*, 2009). The first method is to select the area where offenders believe that the risk for being caught is higher than the benefit of the crimes because of open-street CCTV. The second method is to select the area where open-street CCTV can be viewed. In order to avoid ambiguous offender perception, this research adopted the second method.

We defined the target area as the area within 100 m from the open-street CCTV location because the surveillance of this distance was possible in all open-street CCTV locations (see Figure 1 for an illustration). We defined the buffer area as the area from 100 to 250 m away from the open-street CCTV location. The reason is the same as in Ratcliffe *et al*'s (2009,

Table 3: Characteristics of CCTV locations (target areas) during analysis period

Site (#)	*Setting*	*Number of CCTVs*	*Rotation*	*Serious crime*	*Disorder crime*
1	Elementary school	3	360°	1	0
2	Elementary school	3	360°	1	0
3	Elementary school	3	360°	10	11
4	Elementary school	3	360°	18	27
5	Elementary school	3	360°	42	84
6	Elementary school	4	fixed	14	37
7	City center	1	360°	10	26
8	Elementary school	3	360°	1	0
9	Residential area	3	360°	28	32

p. 752) research, where they selected the 'median estimation of the length of a city block' (500 feet or about 152.4 m) as the buffer. Finally, we defined the control area as the area from 400 to 800 m away from the open-street CCTV location. The reasons for the control area are: (i) it was assumed that the area (400–800 m away from open-street CCTV location) was not influenced by open-street CCTV because of the long distance from open-street CCTV, and (ii) it was assumed that because of the proximity to the target area, the control area was policed similarly to the target area and those living there had a similar socio-economic status. This is similar to Ratcliffe *et al*'s (2009) method, in which the number of crime in the control area was designated as police district total crime numbers subtracted by the crime number of target and buffer areas for each open-street CCTV.

We did not apply the criteria by Welsh and Farrington (2002) that each CCTV location should have at least 20 crimes before the implementation of CCTV. If these criteria had been applied, the effects of open-street CCTV in locations with a small number of crimes could not be determined: a question we were interested in examining. We included the open-street CCTV locations that had at least one crime in their target areas during the research period (from 2006 to 2009). Nine open-street CCTV locations that met the criteria were selected for the current research and 11 open-street CCTV locations that did not meet the criteria were excluded.

The nine open-street CCTV locations for this research had different characteristics (Table 3). Seven locations were near elementary schools; one location was the city center; and one location was a residential area. The number of cameras at each site varied from one to four. Eight of the open-street CCTV locations had a CCTV that could rotate 360° and view 100 m away. The remaining location had four fixed CCTVs that viewed all directions 100 m away. Finally, sites varied considerably in terms of the number of serious and disorder crimes at their locations.

Data

We divided the crime data into serious crimes and disorder crimes (Ratcliffe *et al*, 2009). The addresses of 28 940 crimes were successfully geocoded (about 80 per cent), although we could not geocode 7093 crimes. This was because of incomplete address information and incorrect address information due to human error upon data entry. New data were made from the geocoded data, and it included observations during the analysis period (January 2006 to Dececember 2009), which totaled 432 observations (nine open-street CCTV locations × 48 months). Geocoded crimes were aggregated to months for each open-street CCTV location.

Measures

Following Ratcliffe *et al*'s (2009) research, four independent variables and two dependent variables were used for the current study. The independent variables included the length of the month, temporal trend, seasonal effect and camera. We assumed that if there were more days in the month, there was a higher probability of more crime. The temporal trend was defined as the sequential position of each month. One to 48 were given for each Level-1 unit. A positive coefficient of the temporal trend variable signifies crime increases during the analysis period. Conversely, a negative coefficient of the temporal trend variable means crime decreases during the period. The seasonal effect variable was defined as the average monthly temperature based on average daily temperatures. These values were obtained from the Website Weather Underground (www.wunderground.com/history). Finally, the camera variable was defined as whether or not open-street CCTV cameras were implemented. That is, if the open-street CCTV was implemented during a month, the month had the camera variable value of '1', and if the open-street CCTV camera was not implemented during a month, the month had the camera variable value of '0'. Of nine open-street CCTV locations, three open-street CCTV locations were implemented since 10 January 2007 and six were implemented since 1 December 2008.

Statistical analysis

We used two analysis methods: the mixed linear model for repeated measurements and Weighted Displacement Quotient (WDQ). In the mixed model, the Level-1 unit is monthly observations nested in open-street CCTV locations (Snijders and Bosker, 1999; Raudenbush and Bryk, 2002). The dependent variable is crime or disorder. The independent variable of interest indicated whether a camera was operating at this location in a particular month. We controlled for seasonal effects, pre-existing temporal trends and length of month. We used a Poisson distribution with over-dispersion because the two dependent variables (serious crime and disorder crime) are skewed (Ratcliffe *et al*, 2009). Varying slopes were used for the temporal trend and camera variables because the influences of the variables on crimes were expected to be different among camera locations. Fixed slopes were used for the length of the month and seasonal effect variables because the influences of the variables on crimes were not expected to be different between camera locations.

The formula of a mixed linear model for repeated measures is as follows:

Level-1:

$$\begin{aligned}\text{CrimeCount}_{it} &= \beta_{0i} + \beta_{1i}(\text{Length of month}) + \beta_{2i}(\text{Temporal trend}) \\ &+ \beta_{3i}(\text{Seasonal effect}) + \beta_{4i}(\text{Camera}) + r_{it}\end{aligned}$$

Level-2:

$$\beta_{0i} = \gamma_{00} + u_{0i}$$
$$\beta_{1i} = \gamma_{10}$$
$$\beta_{2i} = \gamma_{20} + u_{2i}$$
$$\beta_{3i} = \gamma_{30}$$
$$\beta_{4i} = \gamma_{40} + u_{4i}$$

where: CrimeCount_{it} is the number of crimes occurring within the camera target area for camera location i at time t; β_{0i} is the mean crime count in camera location i; β_{1i} is the slope coefficient for the length of the month for camera location i; β_{2i} is the slope coefficient for the linear temporal trends at camera location i; β_{3i} is the slope coefficient for the impact of seasonal trends at camera location i; β_{4i} is the slope coefficient for the dummy variable representing camera implementation at camera location i; r_{it} is the residual (unexplained variance), γ_{00} is the average intercept between camera locations; γ_{10}, γ_{30} are the fixed slopes for the length of the month and the seasonal effect; γ_{20}, γ_{40} are the varying slopes for the temporal trend and camera implementation; u_{0i}, u_{2i}, u_{4i} are residuals between the intercepts of Level-2, the temporal trend slopes and the camera slopes, respectively.

A mixed linear model for repeated measures cannot find the crime-reduction effects for each open-street CCTV location. Thus, we used Bowers and Johnson's (2003) WDQ to find crime prevention effects, the effects of displacement and the diffusion of benefits in each open-street CCTV location. The WDQ formula is as follows:

$$WDQ = \frac{\{(B_{t1}/C_{t1}) - (B_{t0}/C_{t0})\}}{\{(A_{t1}/C_{t1}) - (A_{t0}/C_{t0})\}}$$

where: A is the number of crimes in the target area; B is the number of crimes in the buffer area; C is the number of crimes in the control area; t_1 is the time after the CCTV(s) had been implemented; t_0 is the time before the CCTV(s) had been implemented.

The WDQ formula consists of the displacement measure of the buffer area $\{(B_{t1}/C_{t1}) - (B_{t0}/C_{t0})\}$ and success measure of the target area $\{(A_{t1}/C_{t1}) - (A_{t0}/C_{t0})\}$. We used the following procedure. First, we examined the success measure. A positive success measure means that crime was not reduced in the target area compared with the control area after open-street CCTV implementation. In this case, displacement is irrelevant, so the WDQ value is not calculated. Second, a negative success measure signifies that crime is reduced in the target area compared with the control area after open-street CCTV implementation. In this case, the displacement measure needs to be calculated. A positive displacement measure means that the displacement effect emerged in the buffer area after open-street CCTV implementation. A negative displacement measure means that a diffusion of benefits emerged from the target area to the buffer area.

The WDQ value can be interpreted in several ways (Bowers and Johnson, 2003). A WDQ that is greater than 1 means that both the target area and the buffer area had crime-reduction effects. That is, the successful crime-reduction effects of the target area highly influenced the crime-reduction effects of the buffer area. A WDQ that is between 0 and 1 means that the diffusion of benefits from the target area to the buffer area is not great compared with the crime-reduction effects of the target area. A WDQ that is between 0 and −1 means that there is a displacement effect from the target area to the buffer area. A WDQ that is below −1 means that the displacement effect from the target area to the buffer area is higher than the crime-reduction effects of the target area.

Results

Serious crime

There were no statistically significant relationships (P>0.05) between crime and temporal trends or season across all open-street CCTV locations. However, the number of days per month had a significant effect on serious crime. The camera variable showed no significant effect on serious crime (P>0.05), meaning that, on average, the implementation of open-street CCTV did not significantly influence serious crime while controlling for the length of the month, temporal trend and season. Variance components for temporal trend and camera variables were significant (P<0.05), showing that the influences of temporal trend and camera variables on serious crime were significantly different among open-street CCTV locations. Table 4 presents the result of a mixed linear model for repeated measures.

Table 5 shows the WDQ for serious crime and provides the CCTV implementation date, success measure, displacement measure and WDQ in each CCTV location. The crime-reduction effects for serious crime emerged in three CCTV locations (#2, #4 and #6) and there were no crime-reduction effects for serious crime in the other five CCTV locations. The success measure could not be calculated in one open-street CCTV location (#1) because there was no serious crime in the control area before open-street CCTV implementation. The displacement measures and WDQ were calculated in the three CCTV locations, which

Table 4: Mixed model results for serious crime

Effects	*Coefficient (SE)*	*Event rate ratio*	*Confidence interval*
Fixed			
Length of month	0.131 (0.051)*	1.140	1.032–1.259
Temporal trend	−0.023 (0.016)	0.978	0.943–1.014
Seasonal effect	−0.000 (0.003)	1.000	0.993–1.006
Camera	0.527 (0.514)	1.695	0.544–5.279
Effects	*Variance component*	χ^2	*DF*
Random			
Between camera (Level-2)			
Intercept	0.739*	18.475	8
Temporal trend	0.002*	24.652	8
Camera	1.448*	23.853	8
Within camera (Level-1)			
Residual variation	0.828		

*P<0.05.
Dependent variable was specified by Poisson distribution with over-dispersion. Temporal trend and camera variables were specified as varying slope. Length of month and seasonal effect variables were specified as fixed slope.

Table 5: WDQ for serious crime

Crime type	*CCTV site*	*Implementation date*	*Success measure*	*Displacement measure*	*WDQ*
Serious crime	1	1 December 2008	Cannot produce because of the value of 0 for the control area before CCTV implementation		
	2	1 December 2008	−0.2500	−0.5000	2.0000
	3	1 December 2008	0.0095		
	4	1 December 2008	−0.0512	−7.0000	0.3589
	5	1 December 2008	0.0923		
	6	1 December 2008	−0.0183	−0.0135	0.7391
	7	10 January 2007	0.0915		
	8	10 January 2007	0.0526		
	9	10 January 2007	0.0247		

Displacement effect and WDQ were calculated when success measure was negative.

showed crime-reduction effects for serious crime. The value of the WDQ showed that one open-street CCTV location (#2) had crime-reduction effects for serious crime and a strong diffusion of benefits from the target area to the buffer area (WDQ>1). Two open-street CCTV locations (#4 and #6) had crime-reduction effects for serious crime, and a slight diffusion of benefits from the target area to the buffer area (0<WDQ<1).

Disorder crime

The temporal trend variable showed that there were no significant linear crime trends during the analysis period ($P>0.05$). The length of the month and seasonal effect variables were also not statistically significant ($P>0.05$). The camera variable also showed a non-significant effect on disorder crime ($P>0.05$), meaning that the implementation of open-street CCTV did not significantly influence disorder crime, on average, while controlling for the length of the month, temporal trend and seasonal effect. The variance components for temporal trend and camera variables were significant ($P<0.05$), meaning that the influences of temporal trend and camera variables on disorder crime were significantly different between open-street CCTV locations. Table 6 shows the result of the mixed model analysis.

Table 7 shows the information about the WDQ values of disorder crime. The crime-reduction effects for disorder crime emerged in five open-street CCTV locations (#3, #5, #6, #7 and #9). For these locations, the displacement measures and WDQ were calculated. The value of the WDQ showed that open-street CCTV locations #3 and #7 had crime-reduction effects for disorder crime and a strong diffusion of benefits from the target area to the buffer area (WDQ>1). Open-street CCTV location #5 had a crime-reduction effect for disorder crime, with a slight displacement effect from the target area to the buffer area (−1<WDQ<0). Open-street CCTV locations #6 and #9 had crime-reduction effects for disorder crime, with a strong displacement effect from the target area to the buffer area (WDQ<−1). Finally, there were no crime-reduction effects for disorder crime in the other four open-street CCTV locations (#1, #2, #4 and #8).

Table 6: Mixed model results for disorder crime

Effects	*Coefficient (SE)*	*Event rate ratio*	*Confidence interval*
Fixed			
Length of month	0.057 (0.164)	1.058	0.768–1.459
Temporal trend	0.008 (0.015)	1.008	0.975–1.042
Seasonal effect	0.001 (0.003)	1.001	0.995–1.007
Camera	−0.026 (0.322)	0.974	0.479–1.982
Effects	*Variance component*	χ^2	*DF*
Random			
Between camera (Level-2)			
Intercept	5.413**	204.769	8
Temporal trend	0.002*	21.664	8
Camera	0.795*	15.524	8
Within camera (Level-1)			
Residual variation	0.782		

*P<0.05; **P<0.001.
Dependent variable was specified by Poisson distribution with over-dispersion. Temporal trend and camera variables were specified as varying slope. Length of month and seasonal effect variables were specified as fixed slope.

Table 7: WDQ for disorder crime

Crime type	*CCTV site*	*Implementation date*	*Success measure*	*Displacement measure*	*WDQ*
Disorder crime	1	1 December 2008	0		
	2	1 December 2008	0		
	3	1 December 2008	−0.0254	−0.1184	4.6606
	4	1 December 2008	0.1360		
	5	1 December 2008	−0.2378	0.1258	−0.5289
	6	1 December 2008	−0.0068	0.0460	−6.7434
	7	10 January 2007	−0.3727	−1.9894	5.3374
	8	10 January 2007	0		
	9	10 January 2007	−0.0059	0.1014	−17.1577

Displacement effect and WDQ were calculated when success measure was negative.

Discussion

Neither of the mixed models analyzed produced statistically significant effects of open-street CCTV on serious crimes and disorder crimes after controlling for the length of the month, temporal trend and seasonal effect variables. The result is in partial agreement with Ratcliffe *et al*'s (2009) finding that open-street CCTV did not significantly affect the reduction of serious crime, whereas it significantly affects the reduction of disorder crime.

The number of crimes within the open-street CCTV target areas may have been responsible for these results. Some open-street CCTV locations had fewer crimes during the analysis period. Three open-street CCTV locations had just one crime during the analysis period. Given that the vast majority of CCTV sites in Chuncheon had little or no reported serious crime or disorder events, the results here may be more typical of CCTV sites than would be the case if only high-crime or disorder sites were selected.

Variance components for temporal trend and camera variables were significant ($P<0.05$) for both serious crime and disorder crime, showing that the temporal trend and camera variables significantly affected overall crime differently, depending on CCTV locations. This may be due to the difference between the characteristics of CCTV locations (for example, one near a city center, one in a residential area and seven near elementary schools). As the different characteristics may influence crime frequency, each CCTV location may show different crime trends and CCTV effects on crime. Furthermore, WDQ results showed that the open-street CCTV's influence on crime depended on the locations. While open-street CCTV locations #2 and #4 had reduction effects on serious crime, and open-street CCTV locations #3, #5, #7 and #9 had reduction effects on disorder crime, only open-street CCTV location #6 showed reduction effects both on serious crime and disorder crime. A diffusion of benefits emerged from the target area to the buffer area in all three open-street CCTV locations in which open-street CCTVs had reduction effects on serious crimes. A diffusion of benefits also emerged in three of the five open-street CCTV locations in which open-street CCTVs had reduction effects on disorder crimes. Overall, the WDQ result is the same as the result of previous research that showed displacement effects depending on locations and the types of crime (Ratcliffe *et al*, 2009; Waples *et al*, 2009; Caplan *et al*, 2011).

The results of the mixed model and WDQ have several implications. First, open-street CCTVs did not have an effect on crime reduction on average, but the effects differ depending on the open-street CCTV locations. This result corresponds with the previous studies that found that open-street CCTVs had an effect on mainly car parks, but little to no effect in residential areas, city centers or other places (Sivarajasingam and Shepherd, 1999; Welsh and Farrington, 2002, 2003, 2004, 2009; Gill and Spriggs, 2005; Farrington *et al*, 2007). Second, the results showed that open-street CCTVs could have significant crime-reduction effects if they were implemented in the appropriate locations. For example, the #7 open-street CCTV location was within a city center, where many people passed. This location had the highest success measure and diffusion of benefits for disorder crime. Other open-street CCTV locations were near elementary schools and within a residential area. Compared with the #7 location, those open-street CCTV locations were areas that a relatively small number of people passed. Therefore, the result indicated that open-street CCTV could have significant reduction effects on disorder crime if open-street CCTVs were implemented in areas with high traffic. This result may be caused by a greater awareness of open-street CCTVs' use in those locations.

Another important question is whether CCTV at low-crime sites would be less effective than CCTV at high-crime locations. Although we have too few sites to formally test this hypothesis, we can use data to determine if this hypothesis is obviously credible. Table 8 ranks the nine sites by their serious crime rate and disorder crime rate in the months before implementing open-street CCTV. We calculated the crime rate by the number of crimes divided by the number of months before implementation.

We can draw two conclusions from this analysis. First, we know that a WDQ cannot be calculated for sites with a crime rate of 0. This methodological observation has important substantive implications. If crime rate is as low as it can get, open-street CCTV cannot reduce crime further. These sites do not appear to be good candidates for installing CCTV. Second, if the site has a crime rate above 0, it is not obvious that the crime rate is strongly

Table 8: Crime rates and WDQ of CCTV locations

Serious crime			*Disorder crime*		
CCTV site	*Crime rate before CCTV*	*WDQ*	*CCTV site*	*Crime rate before CCTV*	*WDQ*
8	0.0000		1	0.0000	
1	0.0286		2	0.0000	
3	0.0286		8	0.0000	
2	0.0286	2.0000	3	0.2286	4.6606
7	0.0833		4	0.4000	
6	0.3143	0.7391	6	0.7714	−6.7434
9	0.3333		9	0.8333	−17.1577
4	0.4000	0.3589	7	1.0000	5.3374
5	0.9429		5	1.9143	−0.5289

Crime rate: Number of crime/number of months.

related to CCTV effectiveness. Overall, for both serious and disorder crimes, in Table 8 we see low-crime rate sites with high WDQs and high-crime sites with low WDQs.

The results imply that open-street CCTVs can have substantial crime-reduction effects in locations with low-crime rates. Consequently, high levels of serious crime or disorder crime before implementation may not be strong predictors of the effectiveness of open-street CCTV, and it may be worthwhile to implement CCTV on open streets in some circumstances when serious crime or disorder crime is low. Although these results are very tentative, they do suggest that we need more evaluations of low crime and low disorder site CCTV interventions. Consequently, evaluators will have to find ways to address the statistical power of their evaluations, aside from the following Welsh and Farrington's (2002) criteria that only sites with at least 20 events should be examined. Low-crime rate sites cannot be evaluated using these criteria. For those sites that have less serious and disorder crime rates, however, stretching the pre-implementation and post-implementation evaluation periods may be productive. Similarly, simultaneously evaluating large number of low-rate sites may be useful.

As with most research, the current study has several limitations. First, about 20 per cent of police crime data could not be geocoded and could not be used for analysis. This high volume of missing data might affect the results of our data analysis. Second, a mixed linear model for repeated measurements could not analyze the crime-reduction effects of each open-street CCTV. To overcome this limitation, the WDQ was also used for this research. Unlike the mixed model, the WDQ cannot control for the seasonal effect or crime trend. However, the WDQ can compare crime-reduction effects in target areas with the crime-reduction effects in a control area (Ratcliff *et al*, 2009). Thus, the WDQ enables an evaluation of each open-street CCTV location.

Conclusion

The current research used a mixed linear model for repeated measurements to analyze the open-street CCTV reduction effects on serious crime and disorder crime, after controlling for the length of the month, seasonal effect and temporal trend. A WDQ was also used for analyzing the reduction effects on serious crime or disorder crime in each open-street CCTV location. The result of the mixed model showed that, on average, open-street CCTV did not have a statistically significant reduction effect on serious crime and disorder crime. The result of the WDQ indicated that the crime-reduction effects of open-street CCTV were different in each open-street CCTV location.

The effects of open-street CCTVs were different depending on the characteristics of locations. The crime-reduction effects of open-street CCTVs near elementary schools showed mixed results. The open-street CCTV in the city center had strong reduction effects on disorder crime. The site showed strong diffusion of benefits after CCTV implementation. The open-street CCTV in a residential area did not show crime-reduction effects. The site did not have reduction effects on serious crime. Rather, it had a strong displacement effect on disorder crime. Furthermore, the results of this research implied that would-be offenders might not commit a crime if they knew of the existence of open-street CCTVs. Hence, in order to reduce crime, efforts should be made to publicize open-street CCTV by signage, police emblems, flashing lights and media campaigns. Even though the organization that operates open-street CCTV may not like publicizing their use because of other purposes such as supporting an investigation or surveillance on criminals, making open-street CCTV public is essential for prevention and deterrence of crime. In addition, as Wilson and Sutton (2003) found, the publicity of open-street CCTV can also decrease law abiding citizens' fear of crime when passing through open-street CCTV locations.

This research contributes to the generalization of crime-reduction effects of open-street CCTV. The findings show that the results of previous open-street CCTV evaluations, conducted in European and North-American open-street CCTVs, could be applied to South-Korean open-street CCTVs. In addition, the article contributes to improving our understanding about the difference of crime-reduction effects between open-street CCTV locations (elementary school, residential area and city center). The research studied the difference of crime-reduction effects between CCTV locations in a single research, unlike the previous research that used meta-analysis.

Future research is expected to do several things. First, to avoid losing a substantial volume of data, which might affect the results of data analysis, a study should use police crime reports that have accurate address information for geocoding. Second, the characteristics of open-street CCTV locations should be controlled for. That is, each analysis needs to be conducted after dividing open-street CCTV locations into several characterized locations, such as a school area, a residential area and a commercial area. This process will provide a clearer understanding about a specific impact of CCTV on a specific space. Third, it is meaningful to compare the open-street CCTV effects on those crimes that are expected to be influenced by open-street CCTV with those that are not. Such research can give more precise information about the crime-reduction effects of open-street CCTV. Finally, more research on Asian countries' open-street CCTVs is necessary. The research will also help to generalize the results of previous research.

References

Bowers, K.J. and Johnson, S.D. (2003) Measuring the geographical displacement and diffusion of benefit effects of crime prevention activity. *Journal of Quantitative Criminology* 19(3): 275–301.

Caplan, J.M., Kennedy, L.W. and Petrossian, G. (2011) Police-monitored CCTV cameras in Newark, NJ: A quasi-experimental test of crime deterrence. *Journal of Experimental Criminology* 7(3): 255–274.

Farrington, D.P., Gill, M., Waples, S.J. and Argomaniz, J. (2007) The effects of closed-circuit television on crime: Meta-analysis of an English national quasi-experimental multi-site evaluation. *Journal of Experimental Criminology* 3(1): 21–38.

Gill, M. (ed.) (2006) CCTV: Is it effective? In: *The Handbook of Security*. New York: Palgrave Macmillan, pp. 438–461.

Gill, M. and Spriggs, A. (2005) *Assessing the Impact of CCTV*. London: Research, Development and Statistics Directorate, (Home Office).

La Vigne, N.G., Lowry, S.S., Dwyer, A.M. and Markman, J.A. (2011a) *Using Public Surveillance Systems for Crime Control and Prevention: A Practical Guide for Law Enforcement and Their Municipal Partners*. Wahsington DC: Urban Institute, http://www.urban.org/publications/412402.html, accessed 23 October 2011.

La Vigne, N.G., Lowry, S.S., Markman, J.A. and Dwyer, A.M. (2011b) *Evaluating the Use of Public Surveillance Cameras for Crime Control and Prevention*. Wahsington DC: Urban Institute, http://www.urban.org/publications/412403.html, accessed 23 October 2011.

Norris, C. and Armstrong, G. (1999) *The Maximum Surveillance Society: The Rise of CCTV*. Oxford: Berg.

Phillips, C. (1999) A review of CCTV evaluations: Crime-reduction effects and attitudes towards its use. *Crime Prevention Studies* 10: 123–155.

Ratcliffe, J.H. (2006) *Video Surveillance of Public Places*. Problem-Oriented Guides for Police Response Guides Series. No. 4. Washington DC: Office of Community Oriented Policing Services. U.S. Department of Justice.

Ratcliffe, J.H., Taniguchi, T. and Taylor, R.B. (2009) The crime-reduction effects of public CCTV cameras: A multi-method spatial approach. *Justice Quarterly* 26(4): 746–770.

Raudenbush, S.W. and Bryk, A.S. (2002) *Hierarchical Linear Models: Applications and Data Analysis Methods*. Thousand Oaks, CA: Sage.

Short, E. and Ditton, J. (1998) Seen and now heard: Talking to the targets of open street CCTV. *British Journal of Criminology* 38(3): 404–428.

Sivarajasingam, V. and Shepherd, J.P. (1999) Effect of closed circuit television on urban violence. *Journal of Accident & Emergency Medicine* 16(4): 255–257.

Snijders, T. and Bosker, R. (1999) *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. Thousand Oaks, CA: Sage.

Surette, R. (2006) CCTV and citizen guardianship suppression: A questionable proposition. *Police Quarterly* 9(2): 100–125.

Waples, S., Gill, M and Fisher, P. (2009) Does CCTV displace crime? *Criminology & Criminal Justice* 9(2): 207–224.

Webster, W.R. (2004) The diffusion, regulation and governance of closed-circuit television in the UK. *Surveillance & Society* 2(2): 230–250.

Welsh, B.C. and Farrington, D.P. (2002) *Crime Prevention Effects of Closed Circuit Television: A Systematic Review*. Home Office Research Study, No. 252. London: Home Office.

Welsh, B.C. and Farrington, D.P. (2003) Effects of closed-circuit television on crime. *The Annals of the American Academy of Political and Social Science* 587(1): 110–135.

Welsh, B.C. and Farrington, D.P. (2004) Surveillance for crime prevention in public space: Results and policy choices in Britain and America. *Criminology & Public Policy* 3(2): 497–526.

Welsh, B.C. and Farrington, D.P. (2009) Public area CCTV and crime prevention: An updated systematic review and meta-analysis. *Justice Quarterly* 26(4): 716–745.

Williams, D. and Ahmed, J. (2009) The relationship between antisocial stereotypes and public CCTV systems: Exploring fear of crime in the modern surveillance society. *Psychology, Crime & Law* 15(8): 743–758.

Wilson, D. and Sutton, A. (2003) *Open-Street CCTV in Australia*. Trends & Issues in Crime and Criminal Justice, No. 271. Canberra, Australia: Australian Institute of Criminology.