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# The Impact of Closed-circuit Television System on Crime in Korea

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors SB and JK designed the study and wrote the first draft of the manuscript. Author SL performed the statistical analysis of the study. All authors read and approved the final manuscript.*

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## ABSTRACT

The current research investigated whether open-street CCTV (Closed Circuit Television) system reduces crime or not. Crime data and open-street CCTV data from a Korean city were used to find the answer to the research question. The research designated all crime, serious crime, and disorder crime variables as response variables, and camera, length of month, trend, and seasonal effect variables as predictor variables. Multiple linear regression and Possion regression model were used for analyzing the data. Appropriate model was developed for each response variables after checking various methods. The findings showed that open-street CCTV had mixed effects on crime depending on crime types.

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## 1. INTRODUCTION

Many countries have implemented open-street CCTV (Closed Circuit Television) system that is installed in the street to prevent crime. However, most research on the influences of open-street CCTV on crime has been conducted in western countries including the United Kingdom, the United States of America, Canada, and Australia. Thus, we cannot know well the influences of open-street CCTV on crime in Asia. This research focuses on the influences of the open-street CCTV on crime in Korea, one of the Asian Countries where open-street CCTV has been implemented prevalently. The findings will show whether open-street CCTV reduces crime or not. The findings can also show whether the influences of open-street CCTV on crime in Asian countries are similar or not to western countries.

The City of Chuncheon, Korea was selected as research area. The city has 260,000 populations and has implemented open-street CCTVs to reduce crime since 2008. We selected the city as our research area considering the population, the number of crimes, and the number of open-street CCTVs. Then, we analyzed crime data and open-street CCTV data from the Chuncheon Police Station.

This research analyzed the influences of open-street CCTV on crime. We designated all crime (all crime during analysis period), serious crime (serious crime during analysis period), and disorder crime (all crime minus serious crime) as response variables for the purpose. We used multiple linear regression and poisson regression to make our analysis more precise.

We found that open-street CCTV reduced all crime and disorder crime. However, we did not find that open-street CCTV reduced serious crime. The results are similar to the findings of various research that was conducted in western countries [1,2,3,4,5]. That is, implementation of CCTV had mixed effects on crime.

Existing literature gives insights into the impact of CCTV on crime. Varying degrees of crime prevention impact were witnessed by crime type. For instance, previous studies have showed that CCTV reduces incidents of disorderly conduct, but it does not affect the rates of serious crime such as shooting incidents [3]. In addition, property crime decreases once CCTV is installed [6], violent crime rates remain stable [4,7].

## 2. DATA DESCRIPTION

We used three data sources for our project. The first one is crime data from Chuncheon Police Station, Korea. The data includes the date, the type of each crime incident from Jan. 2006 to Dec. 2009. The second one is open-street CCTV data from the same Police Station. The data include the date and place for each CCTV to be implemented. The third one is temperature data from web site Weather Underground (www.wunderground.com/history). We got information on average temperature of each month from the web site to get more precise results of the influences of open-street CCTV on crime in Korea.

Using the data, we made a table to analyze the influences of open-street CCTV on crime. First, we selected one open-street CCTV location which has many crime incidents before and after the implementation of open-street CCTV. Three open-street CCTVs were

implemented in Jan. 2009 in the location. Second, we designated 100 m away from the open-street CCTV as a target area because one of the three open-street CCTVs can rotate 360° and surveillance 100 m away. The other two ope n-street CCTVs cannot rotate but can surveillance 100 m away. Third, we decided a month of the open-street CCTV location as the unit of analysis. Thus, we can have 48 samples (each monthly observation from Jan. 2006 to Dec. 2009).

Fourth, we decided three response variables (all crime, serious crime, and disorder crime) and four predicted variables (length of month, seasonal effect, trend, and Camera). All crime means monthly number of all crime incidents reported to the police. Serious crime means monthly number of serious crime incidents and disorder crime means number of monthly crime incidents excluding serious crime. We followed Korean Police's standard for selecting the type of crime. Length of month is the number of days in each month and seasonal effect is average temperature of each month. Trend is the order of each month and CCTV is whether open-street CCTV is implemented or not in each month. The variables were selected by previous research [3]. Finally, we made an excel table that includes the three response variables and the four predicted variables.

The histograms for all crime and disorder crime were approximately normally distributed (see Appendix 1). However, the histogram for serious crime reflected highly right skewed distribution (see Appendix 2). The scatterplot matrix between the variables showed that there is no linear relationship between the variables. That is, most scatter plots showed randomly scattered cases between two variables. Sequence plot between the response variables and trend variable indicated that there is no significant dependence between each adjacent month.

We got preliminary results using linear regression models. The models used the response variables and the four predictor variables. The analysis using the models showed several preliminary results. First, the implementation of open-street CCTV reduces all crime and disorder crime ($p<0.05$). The multiple linear models with the four predictor variables (camera, length of month, trend and seasonal effect) showed that the implementation of open-street CCTV significantly reduced all crime and disorder crime (see the coefficient and p-value of Camera variable in Appendix 3). Second, the implementation of open-street CCTV does not reduce serious crime ($p>0.05$). The multiple linear models with the four predictor variables (camera, length of month, trend and seasonal effect) showed that the implementation of open-street CCTV did not significantly reduce serious crime (see the coefficient and p-value of Camera variable in Appendix 4). Third, overall crime increases during the analysis period (Jan. 2006 – Dec. 2009). The multiple linear model for all crime with the four predictor variables showed that all crime significantly increased following the order of observation (see the coefficient and p-value of Trend variable in Appendix 3).

Normal probability plots, normality tests and box plots for all crimes and disorder crime showed that the distributions of residuals were relatively normally distributed. However, same plots and tests for serious crime showed that the distribution of residuals was not normally distributed. The results indicated that we needed to take some remedy for serious crime variable.

## 3. METHODS

In this study, three types of dependent variables were measured and this differentiation was based on the standards used by the Korean police. All crime" indicates the overall number of

crime and serious crime includes homicide, rape, robbery theft, arson, assault and drug offenses. All other types of crime were categorized as disorderly conduct.

We used multiple regression models for all crime and disorder crime. However, we used poisson regression for serious crime to remedy the problem of right skewed distribution of the response variable. That is, we took natural log for the serious crime variable. When we transformed the variable, we added 0.0001 in original values of the response variable to include all cases in our analysis because some values of the variable were originally zero. After the transformation, we got distributions for the response variable that is much closer to normal distribution.

We selected the final models for the three response variables after checking $R^2$, Adjusted $R^2$, C (p), MSE, SSE, Press, AIC, and SBC. First, for serious crime, we selected the final model as follows.

$Y_i = \beta_0 + \beta_1 X1_i + \beta_2 X2_i + \beta_3 X3_i + \varepsilon_i$
$Y_i$ : The number of all crime in each month
$X1_i$ : Whether open-street CCTV is implemented or not (Yes = 1, No = 0)
$X2_i$ : The number of days in each month
$X3_i$ : The order of each month (e.g. Jan. 2006 = 1, Feb. 2006 = 2, and Mar. 2006=3)
$\beta_0$ : Intercept of the model
$\beta_1, \beta_2, \beta_3$ : slopes for each predictor variables
$\varepsilon_i$ : random error

Second, for serious crime, we selected the model as follows.

$\log E(Y_i) = \beta_0 + \beta_1 X1_i + \beta_2 X2_i + \beta_3 X3_i$
$Y_i$ : The number of serious crime in each month
$X1_i$ : Whether open-street CCTV is implemented or not (Yes = 1, No = 0)
$X2_i$ : The average temperature of each month
$X3_i$ : The number of days in each month
$\beta_0$ : Intercept of the model
$\beta_1, \beta_2, \beta_3$ : slopes for each predictor variables
$\varepsilon_i$ : random error

Third, for disorder crime, we selected the model as follows.

$Y_i = \beta_0 + \beta_1 X1_i + \beta_2 X2_i + \beta_3 X3_i + \varepsilon_i$
$Y_i$ : The number of all crime in each month
$X1_i$ : Whether open-street CCTV is implemented or not (Yes = 1, No = 0)
$X2_i$ : The number of days in each month
$X3_i$ : The order of each month (e.g. Jan. 2006 = 1, Feb. 2006 = 2, and Mar. 2006 = 3)
$\beta_0$ : Intercept of the model
$\beta_1, \beta_2, \beta_3$ : slopes for each predictor variables
$\varepsilon_i$ : random error

## 4. RESULTS AND DISCUSSION

For all crime, the multiple regression model gave us some information. First, the coefficient of camera variable was -2.39. It means that the implementation of open-street CCTV decreased by 2.3884 crimes controlling for length of month and trend variables ($p<0.05$). Second, the coefficient of trend variable was 0.0631. It means that an increase of the order of observation month decreased by 0.06 crimes controlling for camera and length of month variables ($p<0.05$). However, the coefficient of length of month variable was not significant ($p>0.05$). It means that length of month did not significantly influence all crime controlling for camera and trend variables. The Table 1 shows results for all crime.

**Table 1. Results for all crime**

| Predictor | Coefficient | Standard error | t value | p value |
|---|---|---|---|---|
| Camera (X1) | -2.3884 | 0.9066 | -2.63 | 0.0116 |
| Length (X2) | 0.5070 | 0.3167 | 1.60 | 0.1165 |
| Trend (X3) | 0.0631 | 0.0292 | 2.16 | 0.0359 |

For serious crime, the poisson regression model gave us some information. First, the coefficient of camera variable was not significant ($p>0.05$). It means that the implementation of open-street CCTV did not significantly influence serious crime controlling for seasonal effect and trend variables. Second, the coefficient of seasonal effect variable was not significant ($p>0.05$). It means that seasonal effect did not significantly influence serious crime controlling for camera and trend variables. Third, the coefficient of trend variable was not significant ($p>0.05$). It means that there was no significant trend for serious crime during analysis period controlling for camera and seasonal effect variables. The Table 2 shows results for serious crime.

**Table 2. Results for serious crime**

| Predictor | Coefficient | Standard error | t value | p value |
|---|---|---|---|---|
| Camera (X1) | -1.1654 | 2.2528 | -0.45 | 0.6519 |
| Seasonal (X2) | -0.0229 | 0.0415 | -0.55 | 0.5839 |
| Trend (X3) | 0.0388 | 0.0822 | 0.47 | 0.6391 |

For disorder crime, the multiple regression model gave us some information. First, the coefficient of camera variable was -1.6381. It means that the implementation of open-street CCTV decreased by 1.63 crimes controlling for length of month and trend variables ($p<0.05$). Second, the coefficient of length of month variable was not significant ($p>0.05$). It means that length of month did not significantly influence disorder crime controlling for camera and trend variables. Third, the coefficient of trend variable was not significant ($p>0.05$). It means that there was no significant trend for disorder crime during analysis period controlling for camera and length of month variables. The Table 3 shows results for disorder crime.

**Table 3. Results for disorder crime**

| Predictor | Coefficient | Standard error | t value | p value |
|---|---|---|---|---|
| Camera (X1) | -1.6381 | 0.6975 | -2.35 | 0.0234 |
| Length (X2) | 0.4743 | 0.2436 | 1.95 | 0.0579 |
| Trend (X3) | 0.0423 | 0.0224 | 1.89 | 0.0658 |

In sum, the findings showed that the implementation of open-street CCTV significantly influenced all crime and disorder crime. However, open-street CCTV did not significantly influence serious crime.

There are some discussion points. First, open-street CCTV had significant effects on all crime and disorder crime, however it did not significantly influence serious crime. A plausible explanation is that most of serious crimes are committed by motivated offenders. The offenders commit crime regardless of the implementation of open-street CCTV. In contrast, most of disorder crimes are committed by inadvertent offenders. The offenders will easily stop their offending if they find open-street CCTV.

Second, the length of month variable did not significantly influence all crime and disorder crime. It is not reasonable. Relatively small size of sample (48 cases) may cause the problem. That is, small size of sample might produce relatively high standard error for the coefficient of length of month variable and relatively small t value for the coefficient.

## 5. CONCLUSION

The current research investigated whether open-street CCTV and the findings showed that open-street CCTV had mixed effects on crime depending on crime types. These results were generally supported by numerous studies that confirmed CCTV's effectiveness in preventing crime. Therefore, by using Korean data, this research allows for a generalization of the study results of the effectiveness of CCTV obtained in other countries.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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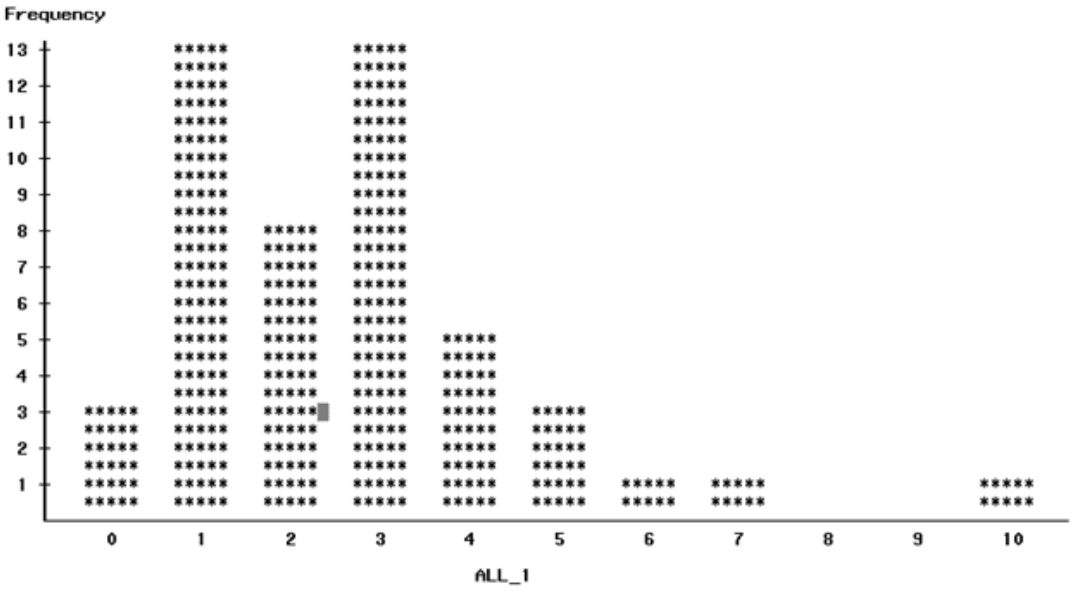
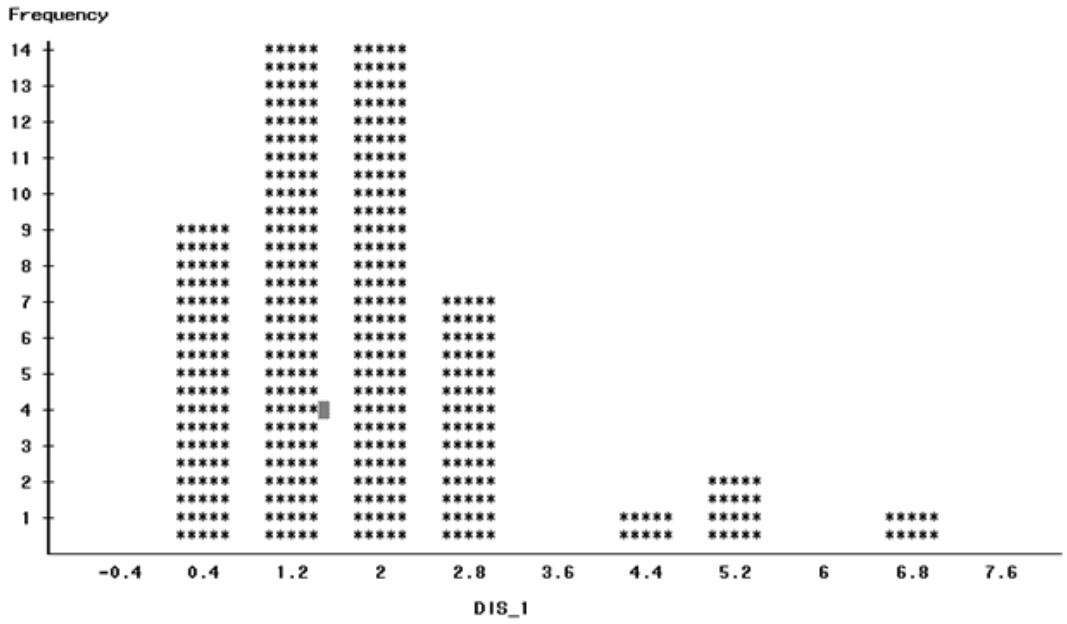
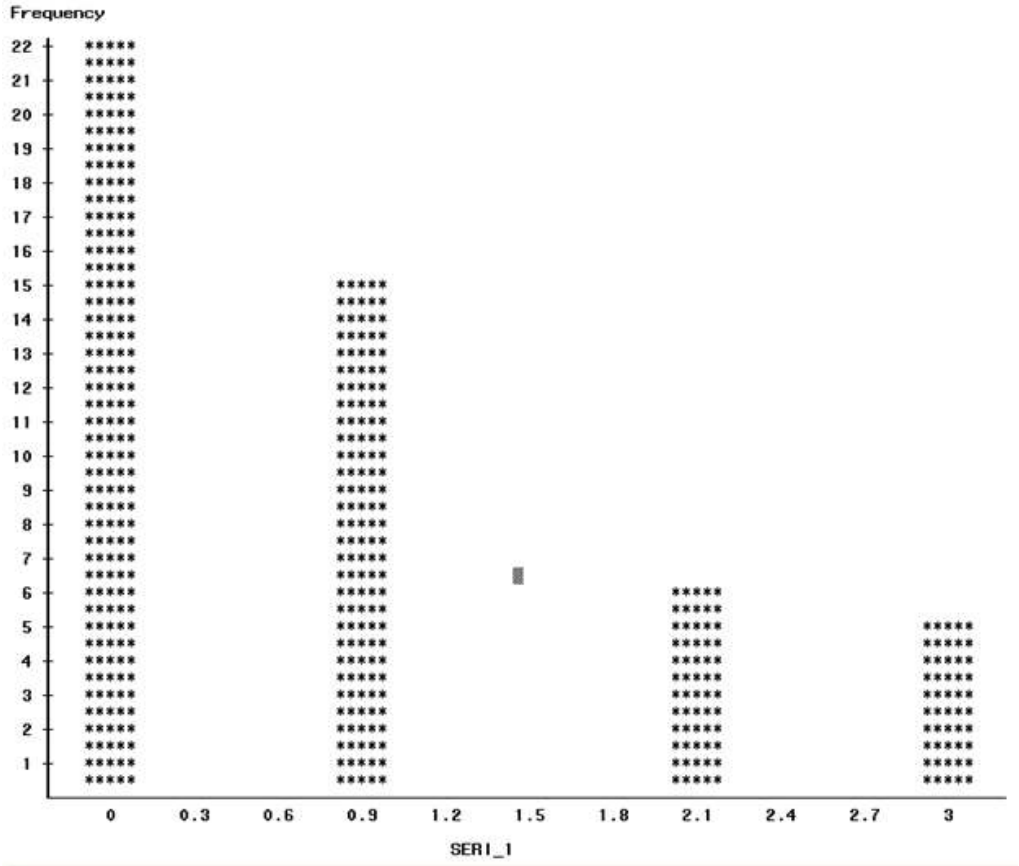
## APPENDIX




**Appendix 1. Histograms for all crime and disorder crime**




**Appendix 2. Histograms for serious crime**

Parameter Estimates

| Variable | Label | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Intercept | Intercept | 1 | -13.69023 | 9.79142 | -1.40 | 0.1692 |
| CAMERA | CAMERA | 1 | -2.38653 | 0.92853 | -2.57 | 0.0137 |
| LENGTH | LENGTH | 1 | 0.50616 | 0.32668 | 1.55 | 0.1286 |
| SEASONAL | SEASONAL | 1 | 0.00019810 | 0.01529 | 0.01 | 0.9897 |
| TREND | TREND | 1 | 0.06305 | 0.02979 | 2.12 | 0.0401 |

Response variable : all crime

Parameter Estimates

| Variable | Label | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Intercept | Intercept | 1 | -12.84976 | 7.51410 | -1.71 | 0.0945 |
| CAMERA | CAMERA | 1 | -1.58598 | 0.71257 | -2.23 | 0.0313 |
| LENGTH | LENGTH | 1 | 0.45135 | 0.25070 | 1.80 | 0.0788 |
| SEASONAL | SEASONAL | 1 | 0.00549 | 0.01174 | 0.47 | 0.6425 |
| TREND | TREND | 1 | 0.04083 | 0.02286 | 1.79 | 0.0811 |

**Appendix 3. Preliminary results for all crime and disorder crime**

*Response variable: disorder crime*

Parameter Estimates

| Variable | Label | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Intercept | Intercept | 1 | -0.84047 | 5.54212 | -0.15 | 0.8802 |
| CAMERA | CAMERA | 1 | -0.80055 | 0.52556 | -1.52 | 0.1350 |
| LENGTH | LENGTH | 1 | 0.05481 | 0.18491 | 0.30 | 0.7683 |
| SEASONAL | SEASONAL | 1 | -0.00529 | 0.00866 | -0.61 | 0.5444 |
| TREND | TREND | 1 | 0.02222 | 0.01686 | 1.32 | 0.1944 |

**Appendix 4. Preliminary results for serious crime**

*Response variable: serious crime*



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