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A Study of Factor Analysis Affecting Major Crimes by Using R Program

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Abstract

CCTV(Closed Circuit Television) is a decisive means in coping with crime investigations and arresting criminals. CCTV not only provides efficient directions for crime investigations but is highly useful to do a security check, personal inquiries, and reconstruction of accidents. However, it is not always safe out of felony or major crimes to install CCTVs in vulnerable crime areas. Furthermore, it is even vague to analyze the causes of major crimes and examination of crime environments. In addition, considering diverse local boroughs in Seoul, it is not simple to assume this or that crime cause. Therefore, this paper investigated the analysis of correlation with major crimes and multiple linear regression analysis through the statistic program R by collecting the number of street lamps, CCTVs, seniors, populations, incoming populations, outcoming populations, and housing owners in each local borough from 2010 to 2014. For this purpose correlation analyzed number of street lamps, incoming population, CCTVs, and seniors respectively. Before analyzing multiple linear regression analysis, we excluded existing inappropriate variables which greatly affect by selecting the greatest subset through the seven independent variables. As a result of the greatest subset, we could find that the independent variables affecting major crimes were the number of street lamp, incoming population and housing owners. According to the result of analyzing subordinate variables and independent variables, each of p-value, R2, was suitable and for the independent variables in connection with reliability scope, all of them were included within the boundary of reliability. In this study using a factor analysis presented are expecting an effect capable of suppressing the violent crimes.

Keywords*: Factor Analysis, Major Crime, R Program, Correlation Analysis, Multiple Linear Regression Analysis*

1. Introduction

Although various IT technologies contributed to our current abundant lives, major crimes also increase in proportion to them. Since after 2000s, five major crimes (murder, robbery, rape and sexual molestation, theft, violence) have continuously on the rise. The tendency of theft and violence accounts for more than 90%; whereas, sexual violence (rape and sexually disgraceful conduct) is steeply on the rise too. According to the average of five major crimes in Seoul for the last three years from 2010 to 2012, it amounts to 131,704 cases. The average case per 100 thousand reaches 1,285 cases [1].

Indeed, there have been made diverse study models at the initial stage of studying crimes. Interestingly, it has been actively studying on what causes crimes with the passage of time.

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Table 1. 5 Major Crime Situation of Seoul

Division	2010	2011	2012	Average
Case per 5 major crime	124,447	132,939	137,725	131,704
Case per 100,000	1,207	1,297	1,351	1,285

Table 2. Frequency of Occurrence of 5 Major Crime Areas

Division	Type	Rank of Crime		
Case per 5 major crime	Murder	Yeongdeungpogu	Gangnamgu	Dongdaemungu
	Robbery	Gangnamgu	Dongdaemungu	Yeongdeungpogu
	Rape	Gangnamgu	Gwanakgu	Seochogu
	Violence	Gangnamgu	Yeongdeungpogu	Jungrangu
	Theft	Gangnamgu	Songpagu	Yeongdeungpogu
Case per density	Murder	Yeongdeungpogu	Geumcheongu	Jongrogu
	Robbery	Dongdaemungu	Gwangjingu	Dongdaemungu
	Rape	Gwanakgu	Gwangjingu	Gwanakgu
	Violence	junggu	Jungrangu	junggu
	Theft	junggu	Gwangjingu	Gwanakgu

There have been preceding studies on the close relationships between major crimes and the correlations with violence and rape or murder and intensity as well [2]. Considering the characteristics of crime vulnerable areas, crimes happens easily around one person family, low income household, districts of many flowing populations as well as narrow alleys. Many studies have been made in terms of spatial perspectives and great efforts are still being made to prevent crimes by improving surrounding environment [3]. For this purpose, it is critical to analyze the causes and factors of crimes in connection with the space study [4].

Therefore, this paper investigated the analysis of correlation with major crimes and multiple linear regression analysis through statistic program R by collecting the number of street lamps, CCTVs, seniors, populations, incoming populations, outcoming populations, housing owners in each local boroughs from 2010 to 2014. This study will certainly be helpful in coping with major crimes in future by referring to the suggestive factor analysis.

2. Releated Study

Diverse studies for preventing crimes have been started from criminology, sociology, and criminals. According to the crime economy theory, all human beings have a free will and choose rational choices by comparing convenience and expenses.

When it comes to the crime economy theory, crimes are closely related to the economic factors. Becker (1968) insisted that the extension of labor market is related to the crime rate. Levitt(2004) concluded that economic factors are less related to the crimes of rape, violence and murder, but considerably related to the crimes of theft, robbery, financial felony, and vehicle crimes [5].

Crimes, from the perspective of crime economy, are formed in the relation of expense convenience and criminal act as a result of rational expectation. That's why it is important to analyze the factors of crimes. Furthermore, crimes occur as their types become subdivided and complicated with the flow of time. More specifically, complicate circumstances like violence or rape are likely to heighten the possibility of crimes, which requires doing practical investigation of the correlation with crimes.

Establishing additional preventive CCTV and the increasing number of police as well as enforcing round of inspection are not only an effective means to prevent crimes but

also to eliminate a sense of uneasiness. Nevertheless, due to the lack of financial budget, practical preventing crimes are not fulfilled. In order to solve these practical issues, CPTED (Crime Prevention through Environmental Design) is considered a potential way to fulfil such a measure [13].

Figure 1. CPTED Diagram

CCTV is divided following its purpose and use such as for protecting children, preventing crimes, for cracking down traffic, for inspecting suspected arrangement traffic, for calamities and damages, and for managing facilities. However, CCTV required in the relationship with CPTED is used for preventing crimes and inspecting arrangement traffic.

For this purpose, Gangdong-gu district upgrade the function of CCTV by applying CPTED to preventing CCTV one step further. When it comes to the selecting places of CCTV, the priority is to analyze the potential place of crimes as well as vulnerable subjects through the technique of big data by cooperating with city police in times of accidents and by applying two million HD ultraviolet cameras [14].

Figure 2. Interrelationships with CCTV and CPTED

As for Yeomri-dong, Mapo-gu district since after April 2012, it has been activating the campaign of "Sogeum-gil Street" so as to keep eyes on the street by linking vulnerable alleys for residents. Furthermore, it has painted the door in yellow and established bright light, camera, and emergency bells by appointing seven "Sogeum Safety Houses" among

those residents who have never involved in crimes and lived there for a long time. For the Sogeum-gil street, it has positively affected to those residents by playing CCTV roles of eliminating a sense of unease through the diverse elements of CPTED.

Park Chul-Hyun, Choi Soo Hyeong(2009)examined how CCTV initially established in Gangnam areas and how it prevented crimes in October 2002 for the last six months and three months respectively. As a result, since after reporting the initial establishment of CCTV in Gangnam-gu district, numbers of burglar and theft has been decreased, whereas those surface crimes such as rapes, murders, and violence disappeared. Plus, with the report of establishing CCTV in Gangnam-gu area, the number of burglar and theft was decreased in those neighborhoods districts such as Seocho-gu, Songpa-gu and others. However, these effects were more evident in case of analyzing them for six months rather than those for three months, which proves that short-term measures are more effective [6].

Min-Hyouk Yim, Jun Hyun Hong(2008) investigated how 24 patrol rounds served as preventive CCTVs in 2008 by limiting the boundary of preventive CCTV by the end of December 2005. As a result, it proved that the establishment of preventive CCTV was not effective to remove those five major crimes per 10,000 people. Therefore, considering the limitation of establishing preventive CCTV, they claimed that it is necessary to work with others [7].

Kang Seok-Jin, Park Ji-Eun, Lee Kyung-Hoon(2009) analyzed the Q and A of those residential subjects for the analysis of effective CCTV to prevent crimes by comparing the current results of research. Thus, they provided the information how numbers of established CCTV in different locations affect to the spatial crimes in road, alley, and theft based on the damages of crime and rates of experiences. As a result, they found that the establishment of CCTV can reduce a feeling of uneasiness for residents [8].

Shin, Woo-Hwa, Shin, Woo-Jin(2012) studied the analysis of correlation with crimes focused on incomplete reconstruction regions due to the prolonged business recession as a part of city readjustment business by dividing them into neighborhoods environment and housing environment [9]. When it comes to physical environment, there were street lamps. Hyo-Chang Lee, Jae-Hwa Lee, Dae-Jin Kim, Mi-Kyoung Ha(2011) suggested that street lamps are needed to promote safe environment from crimes and it needs to maintain luminous intensity continuously so that one can discern people [13].

Likewise, studies on the correlation with city population and crimes are mainly concentrated on a population scale and intensity, movement of population and major crimes. Cho Jongyeop, Baek Yeonsang, Kim Suyeon(2013) examined the correlation with the movement of population rate and major crimes (correlation coefficient: 0.38) and found that strong social connections are closely related to the increasing crime rate. Furthermore, according to them, major crimes happen in the affluent districts rather than the population scale [10].

Oh Mijin(2011) examined that crime rates are higher in the downtown than suburban areas of a metropolis in which flowing population is high. She further studied how the movement of population can more affect crimes rather than the intensity of population. As a usual, crimes happen more frequently especially in the area of many flowing population districts such as entertainment center or accommodation areas. Lee Seongwoo and Cho Joonggu(2006) studied how entertainment centers, restaurants, and accommodation areas are closely related to major crimes.

Lee, Jong-Hoon, Yoo, Seung-Kyu, Kim, Ju-Hyung, Kim, Jae-Jun(2013) further studied how housing values and local characteristics are closely related to the crimes as chief factors of crimes. Physical environment such as CCTVs and street lamps can affect housing values and cause insecurity of residents including the values of real estate [11].

In closing, physical environment such as local characteristics and population are closely related to crimes, not just economic factors and environmental factors like CCTVs.

3. Data Analysis

3.1. Data Collection and Settlement

We downloaded major crime data and CCTV chart data from those of Seoul city. Besides, calculation data come from the government 3.0 public data site (www.data.go.kr) and the data of square, population, senior, incoming population and outcoming population come from Seoul city statistics (stat.seoul.go.kr). When it comes to street lamps, we referred to Seoul open data site (data.seoul.go.kr).

When it comes to housing extension rate, we referred to national statistic site (kosis.kr). We used analyzed data from 2010 to 2014 for five years. However, as long as incoming population and outcoming population are concerned, we downloaded them just in 2010, whose data are collected every five years. In addition, we incorporated downloaded data to analyze them into one and made every objective data as a standard form by setting every data value in every borough per $1km^2$.

Data column name is made up of as follows: borough, Murder, Robber, Rape, Theft, Violence, Number of major crimes, Lamp, CCTVs, Seniors, Population, Incoming_Population, Outcoming_Population, Procession_of_House and Year respectively.

Data column name is made up of as follows: borough, Murder, Robber, Rape, Theft, Violence, Number of major crimes, Lamp, CCTVs, Seniors, Population, Incoming_Population, Outcoming_Population, Procession_of_House and Year respectively.

3.2. Seoul City CCTV Data

Seoul City CCTV data come from the government 3.0 sites in Kangnam, Kangdong, Kangseo, Gwanak, Gwangjin, Geumcheon, Songpa, Yeongdeungpo, Eunpyeong, Jongro borough. The total data are 7,899 cases, in which 5,486 cases were visualized the chart values except for irrelevant CCTVs. In addition, when it comes to other data, there were difficulties in visualizing data provided by Seoul city.

Test_01

Filter

	Country	Murder	Robber	Rape	Theft	Violence	Crime	Lamp	CCTV	Senior	Population	Incoming_Population	Outcoming_Population	Procession_of_House	Year
1	강남구	11	31	176	1962	2824	127	292	15	4334	14609	14076	3072	4901	2010
2	강동구	5	15	98	911	1289	94	233	8	6221	20201	2374	5539	6234	2010
3	강북구	3	10	56	751	982	76	178	5	6835	14831	1659	3959	4869	2010
4	강서구	18	24	140	1739	2030	95	157	4	4751	14022	2132	3824	4528	2010
5	관악구	2	18	103	804	1488	82	168	2	6633	18572	2473	5332	6675	2010
6	광진구	9	40	131	1207	1936	104	283	20	7326	22735	5297	6464	7522	2010
7	구로구	9	18	89	1159	1265	126	313	11	7675	22521	6829	5911	6848	2010
8	금천구	13	57	157	1791	2738	366	358	16	7192	20350	7773	4526	6438	2010
9	노원구	34	74	244	2648	3922	196	242	6	6336	17385	2418	4967	5563	2010
10	도봉구	11	29	99	1360	1790	159	206	3	7221	17910	1780	5132	5644	2010
11	동대문구	8	36	272	1680	2073	267	503	51	11610	26714	9511	6501	8725	2010
12	동작구	11	52	230	2504	2735	337	271	11	10069	25233	5875	7557	8565	2010
13	마포구	7	12	83	775	1194	87	253	7	6695	16826	6548	4598	5677	2010
14	서대문구	8	35	120	1522	1976	208	280	13	8758	18670	7183	4990	6227	2010
15	서초구	19	100	416	3800	5656	213	217	19	3832	9962	5802	2347	2865	2010

Showing 1 to 16 of 125 entries

Figure 3. Completed Data

3.3. Correlation Analysis

As seen in [Figure 3], we have analysed the correlations with subordinate variables and independent variables by using R program regarding entire handling. Moreover, we have established Crime as an independent variable and Lamp, CCTV, Senior, Population, Incoming_Population, Outcoming_Population, Procession_of_House as independent variables. When it comes to all independent variables regarding Crime, it shows as following [Figure 4].

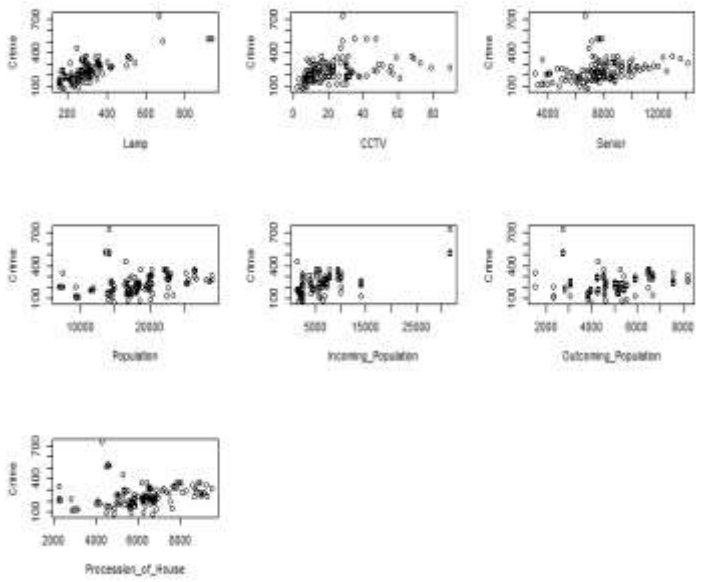

Figure 4. Scattered Chart and Crime Variables

When it comes to high correlation with four variables and scattered chart, it shows as [Figure 5]. More specifically, it demonstrates coefficient as [Table 3].

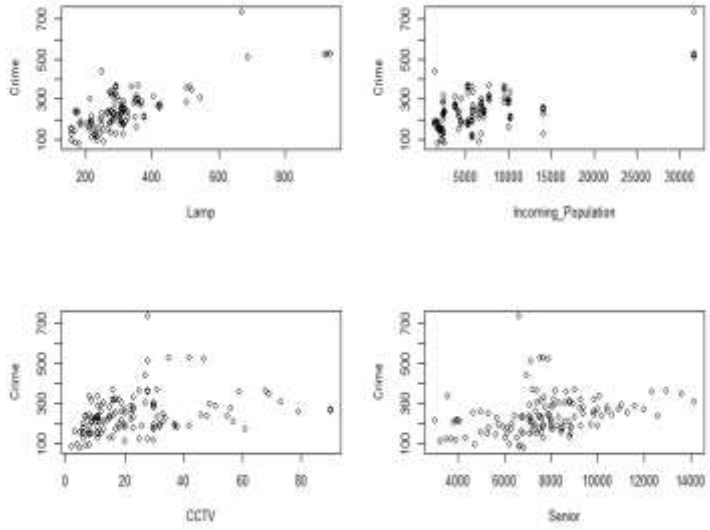

Figure 5. Scattered Chart and High Coefficient Correlation with Crime Variables

Lamp and Incoming_Population greatly effect on Crime through each of 0.74 and 0.69 coefficient and [Figure 5] and [Table 3] graph. Plus, it shows that CCTV and senior less affect crime than Lamp, Incoming_Population. Simply put, it is evident that the more frequent crimes happen, the more lamps, incoming populations, and CCTVs as well as seniors. In other words, the variables affecting Crime are just Lamp, Incoming_Population, CCTV, and Senior. However, it does not indicate the cause and effect on variables but concludes potentiality of its correlation.

Table 3. Scattered Chart and High Coefficient correlation with Crime Variables

Division	Crime	Lamp	Incoming_ Population	CCTV	Senior
Crime	1.00	-	-	-	-
Lamp	0.75	1.00	-	-	-
Incoming Population	0.69	0.85	1.00	-	-
CCTV	0.33	0.48	0.21	1.00	-
Senior	0.31	0.26	-0.08	0.56	1.00

3.4. Selection of the Greatest Subset

We preceded the greatest subset method in order to see the way choosing some variables out of analyzed data in [Figure 3] to analyze multiple linear regressions [12]. According to the coefficient 3.3 analysis, the higher coefficient cannot be the appropriate variable regardless of variable residuals. Therefore, we selected the most proper variable after making possible tests as a type of tournament so as to analyze multiple linear regression in this study.

The less AIC value is the more appropriate values become. Thus variable indicated as "+" is not proper variable in each stage. As a result of the greatest subset, it indicated that Lamp, Incoming_Population, Procession_of_House has the greatest impact on Crime.

```
Start:  AIC=1037.72
Crime ~ Lamp + CCTV + Senior + Population + Incoming_Population +
    Outcoming_Population + Procession_of_House

                        Df Sum of Sq    RSS    AIC
- Population             1        50 443384 1035.7
- Outcoming_Population   1       192 443525 1035.8
- Senior                 1      1165 444499 1036.0
- Procession_of_House    1      1788 445121 1036.2
- CCTV                   1      3345 446679 1036.7
<none>                              443333 1037.7
- Lamp                   1     13589 456922 1039.5
- Incoming_Population    1     51520 494854 1049.5
```

```
Step:  AIC=1035.73
Crime ~ Lamp + CCTV + Senior + Incoming_Population + Outcoming_Population +
    Procession_of_House

                       Df Sum of Sq    RSS    AIC
- Outcoming_Population  1       142 443526 1033.8
- Senior                1      1413 444797 1034.1
- Procession_of_House   1      2529 445912 1034.5
- CCTV                  1      3304 446688 1034.7
<none>                             443384 1035.7
+ Population            1        50 443333 1037.7
- Lamp                  1     14622 458006 1037.8
- Incoming_Population   1     52318 495701 1047.7

Step:  AIC=1033.77
Crime ~ Lamp + CCTV + Senior + Incoming_Population + Procession_of_House

                       Df Sum of Sq    RSS    AIC
- Senior                1      1288 444814 1032.1
- CCTV                  1      3630 447156 1032.8
<none>                             443526 1033.8
+ Outcoming_Population  1       142 443384 1035.7
+ Population            1         1 443525 1035.8
- Lamp                  1     16083 459609 1036.2
- Procession_of_House   1     20508 464034 1037.4
- Incoming_Population   1     61103 504629 1047.9

Step:  AIC=1032.14
Crime ~ Lamp + CCTV + Incoming_Population + Procession_of_House

                       Df Sum of Sq    RSS    AIC
- CCTV                  1      2780 447594 1030.9
<none>                             444814 1032.1
+ Senior                1      1288 443526 1033.8
+ Population            1       170 444644 1034.1
+ Outcoming_Population  1        17 444797 1034.1
- Lamp                  1     18616 463431 1035.3
- Incoming_Population   1     59869 504683 1045.9
- Procession_of_House   1     85325 530140 1052.1

Step:  AIC=1030.92
Crime ~ Lamp + Incoming_Population + Procession_of_House

                       Df Sum of Sq    RSS    AIC
<none>                             447594 1030.9
+ CCTV                  1      2780 444814 1032.1
+ Senior                1       438 447156 1032.8
+ Outcoming_Population  1       243 447351 1032.8
+ Population            1         1 447593 1032.9
- Lamp                  1     15897 463492 1033.3
- Incoming_Population   1     70574 518168 1047.2
- Procession_of_House   1     83126 530720 1050.2
```

Figure 6. Greatest Subset Selection

3.5. Multiple Linear Regression Analysis

As suggested in [Figure 7], we performed Multiple Linear Regression Analysis by selecting Lamp, Incoming_Population, Procession_of_House as independent variables in terms of 3.4 greatest subset selection affecting Crime. As a result, we proved regression model as seen in [Figure 8].

```
Call:
lm(formula = Crime ~ Lamp + Incoming_Population + Procession_of_House,
    data = Sample2)

Coefficients:
        (Intercept)                Lamp  Incoming_Population  Procession_of_House
           7.286115            0.189227             0.009038             0.018873
```

Figure 7. Final Regression Model

```
Call:
lm(formula = Crime ~ Lamp + Incoming_Population + Procession_of_House,
    data = Sample2)

Residuals:
     Min       1Q   Median       3Q      Max
-155.250  -31.565   -4.434   22.451  271.518

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)         7.286115  23.334277   0.312   0.7554
Lamp                0.189227   0.091278   2.073   0.0403 *
Incoming_Population 0.009038   0.002069   4.368 2.66e-05 ***
Procession_of_House 0.018873   0.003981   4.740 5.88e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 60.82 on 121 degrees of freedom
Multiple R-squared:  0.6369,    Adjusted R-squared:  0.6279
F-statistic: 70.74 on 3 and 121 DF,  p-value: < 2.2e-16
```

Figure 8. Multiple Linear Regression Analysis Verification

Multiple R-squared represents R2, which means that a value near to 1 decides the appropriateness of regression model. Whereas, Pr(>|t|) value becomes smaller one less than 0.05 because of the greater possibility of becoming regression coefficient 0 within the scope of 95% reliability. After examining Estimate so as to make sure each and one of independent variables, I have found that every one of them was included within the boundary of reliability such as 0.189227 Lamp and 0.009038 Incoming_Population, and 0.18873 Procession_of_House.

```
                          2.5 %      97.5 %
(Intercept)        -38.910241385 53.48247115
Lamp                 0.008517193  0.36993651
Incoming_Population  0.004941255  0.01313386
Procession_of_House  0.010991004  0.02675499
```

Figure 9. Reliability Scope of Independent Variables

Moreover, when the p-value is less than 0.5, it can be justified that this regression model is statistically proper [12]. Considering [Figure 8] data, R2 shows 0.6369, Pr(>|t|) becomes smaller value less than 0.05, p-value seems to be less than 0.5.

4. Conclusion

In this study, we investigated the analysis of correlation with major crimes and Multiple Linear Regression Analysis through statistic program R by collecting the number of street lamps, CCTVs, seniors, populations, incoming populations, outcoming populations, housing owners in each local boroughs of Seoul from 2010 to 2014.

This study will certainly be helpful in coping with major crimes in future by referring to the suggestive factor analysis. For this purpose, we performed this analysis by using the correlation function providing R program and analyzed number of street lamps (0.7464784), incoming population (0.6907082), CCTVs (0.3348914), and seniors (0.3074769) respectively.

Before analyzing multiple linear regression analysis, we excluded existing inappropriate variables which greatly affect by selecting the greatest subset through the seven independent variables. As a result of the greatest subset, we could find that the independent variables affecting major crimes were the number of street lamp, incoming population and housing owners. According to the result of analyzing subordinate variables and independent variables, the regression values became 0.189227, 0.009038, and 0.018873 respectively. When it comes to model verification, each of p-value, R2, was suitable and for the independent variables in connection with reliability scope, all of them was included within the boundary of reliability.

However, this study has some of limitations and restrictions as well.

First, the correlation analysis and multiple linear regression models are not the result of a cause and effect, but just a straight relationship. Accordingly, one can assume that major crimes are closely related to the number of street lamps. However, one cannot justify them as a cause of effect. More specifically, it needs more additional inner, external, and personal validity including theoretical ground to explicate the cause and effect between subordinate variables and independent variables [12].

Second, the sources of data used in this study were based on the publically accessed data provided by the Korea National Statistical Office and Seoul City. Nevertheless, there were many limitations and restrictions to get access to them.

Unfortunately, we couldn't reflect more possible crime factors. However, it is meaningful for me to have analyzed crime factors through a R program. In closing, it needs further studies on predicting crimes by inducing affecting factors in case data or coordinate values are extended in each administrative authority.

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