

Defining the Patterns and Factors of Urban Crime in Korean Cities Based on the Analysis of Social Statistical Data

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Abstract The high rate of urban crime is a main issue that needs to be dealt with in this high-tech society. With the rapid increase of urban crime, research has mainly focused on topics either on a global or a local scale, such as cities or communities and houses or buildings, without reliable observational data. This study makes the best use of the nationwide surveys carried out by Korean government agencies for the analysis of urban crime patterns and factors in major Korean cities. The aims of this research are threefold: understanding the relationship between urban crime patterns and socio-economic differences in cities, determining the effect of residence types on the urban crime patterns; and uncovering potential influential factors of a crime victim's individual characteristics. The statistical methods used for the analysis of social statistical data are as follows: simple regression, logistic regression, one-way ANOVA and post-hoc test. This research found that the patterns of urban crime rate in cities have a certain tendency toward the cities' socio-economic and geographical differences. The residence type is an influential factor showing a close relation to the crime rate. Personal issues, such as the types of occupation, education, marriage, etc., are directly relevant to victims of crime.

Keywords : Urban Crime, Crime Prevention, CPTED, Urban Safety

1. INTRODUCTION

1.1 Background and purpose of study

Rapid industrialization during the last two centuries has brought about a high rate of urbanization due to the rapid migration of people to big cities in Korea. The rapidly growing modern cities formed by mass influx into the urban population having various individual interests has played a part in every kind of urban problem from poverty, traffic, crime, pollution, and overcrowded housing. Among these, crime is a fundamental problem that threatens all members of society by increasing the anxiety of citizens and lowering the quality of life for all. Therefore, the various studies on crime prevention are of vital importance for urban life.

To date, many research studies regarding the situational crime

prevention theory, which aims to reduce opportunity for crime by improving the community environment and/or eliminating crime factors, have been conducted in the field of criminology. There are several categories of these studies focusing on different theories. The rational choice theory places criminals in an environment where crime is not profitable by making it difficult to access crime targets. The ecological theory considers crime suppression in the design of the buildings and surrounding environments. The routine activity theory suggests that potential crimes have three main elements: potential offenders, suitable targets and the absence of monitoring. The opportunity theory describes crime in terms of the elements of familiarity with the target and usefulness. The goal of this study is to prevent crime by using statistical analysis to study domestic conditions and understand the relationship between crime and the physical and social environment of a city based on these theories of crime prevention.

The crime data for this research study were gathered from reliable statistical database open to the public and collected nationally by government departments including the Korea National Statistical Office, the Ministry of Land, the Ministry of Health and Welfare, and the Public Prosecutor's Office. Statistical data from the database that met the purpose of the research were selected. This study covers all major cities including Seoul and provinces nationwide. The potential crime factors among the huge range of the statistical database of each district were extracted through several stages of statistical processing and analyzed.

Ultimately, the objective of this study is to find a correlation

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between crime occurrences with common characteristics of cities and provinces nationwide, residential environment, and personal properties among a broad range of attributes, as well as to determine crime traits that fit a domestic situation.

1.2 Study method and procedure

(1) Subject of case study

The official crime rate is often defined as the ratio of crimes arrested in an area to the population of that area. It means the official crime rate is recognized and processed by criminal justice institutions such as the police office, which has implicit problems. Missing hidden crimes that are not processed are one of them. Some crimes are neither detected nor reported; some are ignored or not solved by police. Possible errors in organizing and classifying on crime scenes can make the crime rate less reliable. Also, the legal definitions of crimes have been changing over time along with the changes of laws and social systems. Thus, crime victimization data obtained from victims is an alternative way of understanding patterns of crime in the urban environments. Surveys of crime victimization aim to complement official statistics through more accurate observation of crime.

Although crime victimization rate based on field surveys is also controvertible as Hwang and Choi (2009) have pointed out, crime data chosen for this study is based on experience of crime victimization from the social statistical survey for welfare safety and urban environment conducted by the Employment and Welfare Statistics Division of Population and Social Statistics Bureau in the Korea National Statistical Office. The survey takes place every four years and was carried out in July, 2005, for 10 days, with a random sample of 68,474 respondents from 33,000 households nationwide. It contains 'experience of crime victimization' as regards the safety sector. The term crime victimization rate used in this study is defined here as the fraction of the number of respondents that experienced crime victimization once or more among the total number of respondents.

Table 1. Frequency of Crime victimization

Experience of Crime Victimization				
		Frequency	Percent	Valid Percent
Valid	Yes	2200	3.2	7.2
	No	28468	41.6	92.8
	Total	30668	44.8	100.0
Missing	System	37806	55.2	
Total		68474	100.0	

Table 2. Type of Crime Victimization

Case Summary		
	N	Percent
Crime Victimization (Valid)	30668	44.8%
Crime Victimization Experienced	2022	7.2%
Theft damaged	1240	1.8%
Theft not damaged	129	.2%
Theft reported	582	.8%
Theft unreported	897	1.3%
Fraud damaged	704	1.0%
Fraud not damaged	47	.1%
Fraud reported	247	.4%
Fraud unreported	567	.8%
Robbery with property damage	190	.3%
Robbery without property damage	21	.0%

Robbery reported	101	.1%
Robbery unreported	125	.2%
Assault (total number of household)	152	.2%
Assault reported	72	.1%
Assault unreported	100	.1%

The subject of study includes four types of crime: theft, fraud, robbery, and assault. In total, 44.8% of respondents replied with valid answers, and 7.2% of them had experienced crime victimization as shown in Table 1. Table 2 shows types of crime and the valid number of respondents who experienced each crime. Theft, the most frequent crime, also appeared as most experienced by victims. The number of thefts reported (589) is less than unreported (897). This tendency not to report crime is shown on rest of all types of crime. It indicates that there exists a huge gap between actual crimes and officially reported ones.

Table 3. Social Statistical Data

Collected Data	Source
Statistics on the Aged	MOHW [*]
Changes in the Rate of Vital Statistics by Cities and Provinces	NSO ^{**}
Cases and Rate of Vital Statistics by Eup, Myeon and Dong	NSO ^{**}
Fluctuation Rate (by cities and provinces)	MLTM ^{***}
Economically Active Population by Administrative Units (Cities and Provinces)	NSO ^{**}
Number of Major Penal Offenses	SPO ^{****}
Cadastral Statistical Data (the end of 2005)	MLTM ^{***}
Social Indicators in Korea	NSO ^{**}
Social Statistics Survey (Statistical Table)	NSO ^{**}
Social Statistics Survey (Korean)	NSO ^{**}
Statistics of Population Migrating Result	NSO ^{**}
Confirmation and Release of Marriage and Divorce Statistics	NSO ^{**}
Population Density by Cities and Provinces	NSO ^{**}
Cadastral Statistics (based on Oct. 31, 2007)	MLTM ^{***}

^{*} The Ministry of Health and Welfare
^{**} The Korean National Statistics Office
^{***} The Ministry of Land, Transport and Maritime Affairs
^{****} The Supreme Public Prosecutor's Office

First, we analyzed the cross tabulation of crime victimization rate with cities and provinces nationwide. Second, we examined the correlation of crime victimization rate with the socio-economic factors and demographic and physical properties of cities and provinces to find out what ground of the residential environment are linked to crime in global range. Socio-economic environment is considered influential for generating crimes since most types of crimes such as theft, fraud, and robbery occur for financial reason. Demographic and physical elements of the environment in large scaled administrative district would be necessary to examine patterns of crime on different urban environment and to understand influential factors. Global statistical data was collected from various sources of government departments. The initial data at the early stage of the analysis and their source are listed in Table 1. These are the data from 2005 or around the same time when the social statistic survey was conducted, and the data included one study from the Ministry of Health and Welfare, the Supreme Public Prosecutor's Office, etc. Data extracted were used as a main index to reveal a correlation with crime victimization according to cities and provinces by extracting through several steps of statistical processing. The indices that are filtered and reached to

the final stage of the analysis at 0.05 significant level of coefficient correlation analysis from these data with crime victimization rate are categorized as socio-economic factors and demographic factors as shown in Table 4. The table also shows each factor, definition, source of data, and nation's average/maximum value.

Table 4. Local attributes of cities and provinces

Socio-Economic Properties of Cities and their sources			
Factor	Definition	Source	value
Unemployment rate(%)	Unemployed workers over total labor force	NSO ,	3 / Avg
Land Price Change Rate (%)	Land price in recent month over the previous months	KLHC**	0.1/ Avg
Ratio of homeowners (%)	The number of household of house owner over total number of household	NSO*	61.8 / Avg
Size of residential area (Pyeong, 3.3m ²)	Average size of residential area in Pyeong	NSO*	19.7/ Avg
Annual Income (1unit:₩10,000)	Total annual income per household	NSO*	3,035.9/ Avg
Household expenditure (1unit:₩10,000)	Total annual expenditure per household	NSO*	2,353.10 / Avg
Amount of debt (1unit:₩10,000)	Total Amount of debt per household	NSO*	3,035.9 / Avg
Gross Revenue (1unit:₩10,000)	Gross revenue of the city or province	MOPAS****	135,577, 133 / Avg
Number of Recipients of basic living (1unit:₩1,000)	The total number of recipients of basic living.	MOPAS****	1,513 / Avg
Demographic & structural factors			
Population density	Number of people per km ²	NSO****	16,181 /Seoul
Population composition	Percentage of population living in the city or province over total population of the country	NSO****	22 /Kyeonggi
Labor Force Population (1unit : 1,000)	Number of people employed and unemployed over 15 years old	NSO****	5,669 /Kyeonggi
Ratio of detached house (%)	The proportion of household living in detached house over total number of household	NSO****	27 / Avg,, 64 /JunraN amdo
Ratio of apartment house (%)	The proportion of household living in apartment house over total number of household	NSO****	44 /Avg
Ratio of row house (%)	The proportion of household living in row house over total number of household	NSO****	3/ Avg
Ratio of multiplex house(%)	The proportion of household living in apartment house over total number of household	NSO****	8/ Avg
Ratio of non-residential house	The proportion of the household living in non-residential house over total number of household	NSO****	3/ Avg
Ratio of land for farming & fishing(%)	The proportion of land for farming and fishing to total size of land	MOPAS****	86.24 /Avg
Ratio of building area (%)	The proportion of developed area over total size of land	MOPAS****	2.58 / Avg, 35.67 / Seoul

Ratio of road (%)	The proportion of the size of road over total size of land	MOPAS****	2.64 / Avg,
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* National Statistics Office, 2005, Census
 ** Korea Land & Housing Corporation, National Land Department, 2005, 7
 *** Ministry of Public Administration and Security, 2006, Calculated using Status of Land Category(2006)
 **** National Statistics Office (2005, 6) , The Bureau of Social Statistics, Economically Active Population for districts
 ***** Ministry of Public Administration and Security

Finally personal factors that affect crime victimization were analyzed using the social statistical survey for welfare safety and environment data mentioned earlier. It was composed of 12 representative items, including family, income and expenses, labor, education, health, housing and transportation, urban environments, information and communication status, welfare, culture and leisure, and safety and social participation. The data on the basic social research sector and personal awareness of safety, which was believed to have effects on the crime rate directly or indirectly among the contents regarding welfare, safety, and environment, were utilized in the study. Table 5 shows the personal social, economical, and psychological factors regarding safety and their categories classified.

Table 5. Social, economic properties and their categories classified

Factor	Categories classified
Housing type	Detached house / Apartment house/ Row house / Multiplex house
Tenant form	Owned / Leased / Monthly rent with deposit / Monthly rent / Free
Marital status	Single / Married with spouse / Separation by death / Divorced
Education (sequential variable)	Elementary graduated / middle school graduated / high school graduated / college graduated / graduate school graduated
Occupation	Assemblyman, Executives / Crafts and related trade workers / Service workers / Technicians and associate professional / Simple labor workers / Plant, machine, operation and assemblers/ Sales workers / Office workers / Specialist / Skilled agricultural forestry and fishery workers
Status in employment	Regular workers / Temporary workers / employers/ Daily workers / Unpaid family workers / Self-employed
Economic activity	Employed / Unemployed / Non-economically active
Professional position	Regular employee / Temporary worker / Day laborer / Employer / Self-employed / Unpaid family worker /
Disabled	Handicapped welfare card registered
Law-abiding	Classified wit 5 stages
Fear for crime	Classified with 5 level
Fear for working alone	Classified with 5 level
Crime victimization	Experienced / Inexperienced

The study covers a total of 16 cities and provinces, such as Seoul, Pusan, Daegu, Incheon, Gwangju, Daejeon, Ulsan, Gyeonggi, Gangwon, Gyeongnam, Gyeongbuk, Chungnam, Chungbuk, Jeonnam, and Jeonbuk, comprising metro-cities and municipalities.

(2) Statistical analysis method

First, a cross tabulation was created to analyze the relationship between the characteristics of the city and crime patterns. Then, the statistical analysis of Pearson's Correlation Coefficient was carried out to determine the correlation between indices representing

urban characteristics and urban crime rate. We considered an urban characteristic index to be associated with crime when it had a 0.05 significant level. The correlation of crime with properties of city researched through Pearson's Correlation Coefficients Analysis was represented according to classifying negative or positive relationship.

For the analysis of the relationship between personal social and economic characteristics and crime victimization, the Binary Logistic Regression was performed using housing type, tenant forms, occupation and educational background as an independent variable and the experience of crime victimization as a dependant variable. Since this analysis was designed to predict the probability of future crime using past data, after setting the null hypothesis, which is the negative hypothesis, the significance probability was first calculated. If the null hypothesis was rejected, then the result was considered suitable, and if it was not rejected, the result was considered not suitable. Also, as mentioned above, if the significance probability has a value lower than 0.05 then predictive value is considered to be significant.

The statistical method used to analyze the correlation between housing type and crime was One-way ANOVA: Analysis of Variance. The prerequisite to perform this analysis was that the dependent variable should be a quantitative variable. To check the accuracy of the survey, a reliability test was performed. Based on the result of previous One-way ANOVA, the Post-hoc Test was performed to determine where the difference between each group originated. Multiple comparisons were made employing the commonly used Scheffe method and the effects on crime were analyzed after comparing each significance probability.

2. LITERATURE REVIEW

As cities become denser, more information oriented, and more complex, changes are reflected in urban crime pattern. Existing studies about crime prevention on an urban scale can be largely divided into three categories: city crime characteristics, CPTED for city crime prevention, and study related Ubiquitous (U-City) for city crime prevention. The study trends of existing researchers related to this topic are described in the following sections.

2.1 Study of urban crime characteristics

Recent studies analyzing crime factors have focused on various aspects such as socioeconomic ones of city life and spatial environments. This approach considers crime factors as only part of human nature.

Lim (2005) stated that by analyzing the various city properties, crime prevention would be possible in a macro dimension. In addition, his study suggested that in order to have a successful crime prevention program, crime prevention activities along with the formation of an organization targeted at the community were required and aggressive promotion of both would be essential.

Lee and Lee (2009) studied the relationships between crime rates and characteristics of urban areas focusing on populational, social, and economic factors. They reported that property taxes per household, divorce rate, and percentage of youth population among urban characteristics are the main elements that affect crime occurrence. Based on those results, they suggested strengthening family solidarity together with the interests and support for the

youth as crime prevention strategies.

According to a study on urban crime in relation to land use patterns (Kim, Yoon, and Ahn, 2007), the increasing trend in crime rates tends to slow down gradually at around 200% of floor area ratio. This study also noted that the crime density was high when land use and housing type have been mixed in several ways. There was also suggestion that the potential crime would be predictable through the analysis of such land use and house type.

Hur and Moon (2010) referred to crime patterns based on the temporal characteristics together with spatial analysis as seen in previous studies. They stated that violence and theft were most intensive during night-time and late-night. They analyzed hot-spot areas using a space cluster navigation method and preceded this study for effective information collection of areas by making a questionnaire.

Another study was an empirical analysis of crime factors impacting elderly and foreigners residing in the city (Kim and Lee, 2010). They focused on the main motivations for crime and preventive measures associated with the elderly and foreigners, which have been significantly increasing. They suggested that in the case of preventive measures regarding elderly crime, economical support and emotional stability planning should be promoted, and in terms of crime affecting foreigners the investigational organization should be expanded and expertise strengthened. The authors also recommended crime prevention through environment design, improvement of patrol systems, and a review of the school site reduction.

2.2 CPTED related study for urban crime prevention

CPTED(Crime Prevention Through Environmental Design) is a field of crime prevention using architecture and urban environmental design to reduce the level of crime occurrence and fear of crime. This is achieved through the effective use of appropriate design and architecture environment, thus improving the quality of life. Since Jane Jacobs suggested in the 1960s a solution for crime using urban redevelopment through urban design method, the correlation between environmental design and crime has been presented in various books, including "Crime prevention through environmental design" by C. Ray Jeffery and "Defensible space" by Oscar Newman. The related studies were developed in full-scale in the 1970s when the environmental design for crime prevention was beginning to be applied to public facilities and schools as well as residential areas in North American cities.

The study for CPTED mainly suggested solutions that are applicable domestically by studying various overseas cases that are successfully being implemented. However, studies in the following detailed fields are also worth paying attention to.

Park and Kim (2008) suggested CPTED for crime prevention strategy and assignment to sustainable urban design. But they also pointed out that it is still in its beginning stage. They presented a continuous study of related technologies and provided a legal basis for applying systemic crime prevention environmental design and welfare approaches for the economically weak as a first priority.

Studies on the design perspective of CPTED (Chung and Yang, 2010) focus on the development technique for applying elements of CPTED to design by materializing them. There are materialization of physical elements such as access control, surveillance, and granting territoriality. There are also materialization of social

elements for reliability, closeness, and formation of social bond. Based on these detailed design elements, the directions for the CPTED plan are set. It is divided into a physical plan including clear distinction of public and private space and ease of monitoring walking traffic. There is also a non-physical plan including crime prevention facilities and placement of personnel, partnership between police and related organization, administration program, and building an evaluation system.

In addition to the studies mentioned above, various researches on crime prevention are underway focusing on architecture and urban environmental design. However, there is a limit to crime prevention through spatial design due to the large variety of potential crimes. Low domestic awareness of CPTED and the small number of its professional training program are also a problem.

2.3 U-City related study for urban crime prevention

U(Ubiquitous)-City is being considered for implementation in order to build a highly intelligent urban environment that can adapt to cutting-edge information and knowledge society. It is only in the introductory stage, but given that the legislation for U-City is being attempted, it is likely to be a field with high possibility of future development. Therefore, the related legislation promotion that is necessary for U-City development and application and other related studies can be examined.

In a study of the U-crime prevention system of U-City reflecting the plan index of new urban plan (Yoon, 2009), it was suggested the building of a reasonable indicator and standard for a sustainable environmentally-friendly city and housing environment. Comparative analysis was done for a space planning index of a new city and U-City index and various plans including establishment of crime prevention planning technique through CPTED, which is required in new city planning, as well as crime prevention technique through hardware technique such as CCTV were suggested.

In a study of the actual condition of crime in Jinju City and the U-crime prevention system model development (Heo, 2010), the crime pattern was investigated by analyzing time and spatial distribution patterns for crime. It was suggested an achievable technique for model development of U-crime prevention system, implementation environment and methods for U-City business, and a crime prevention scenario based on their results. U-City related studies on making a safer city are being actively pursued through network technology, which is becoming more intelligent.

3. KOREAN CITIES' URBAN CHARACTERISTICS AND CRIME PATTERNS

3.1 Korean cities' urban crime patterns

The research is based on nationwide scale as contrasted with the existing studies as reviewed in previous chapter. Thus, the study or urban crime pattern focuses larger scaled environmental impact of crime patterns. As a first step to determine the aspects of crime victimization in metropolitan cities and provinces in Korea, a crosstab analysis of crime experiences was performed using social statistical survey data for welfare safety environment as mentioned previously. From the initial 28,608 households surveyed the responses of 1,106 were excluded. Therefore, the response results of a final 27,502 household data were analyzed.

We found a correlation between population density and crime

rate with simple regression where the correlation was $r^2=0.405$ ($p=0.0080$), showing that the crime victimization rate is highly related to the urban population density. It becomes more significant with result of $r^2=0.736$ ($p<0.0001$) when the Gyeonggi area is left out. Gyeonggi area is an area where the crime rate is very high even though the population density is very low. This result proved that the analysis was correctly approached showing that the number of respondents in each city was fairly proportional to population density. In addition, it was possible to do inter-comparisons of the crime rates of each district. In the case of the Gyeonggi area, which balances the functions of a capital city area along with many satellite cities around Seoul, the average population density of the total area is low. However, this mainly reflects the characteristics of Seoul as a large metropolis and thus it is considered to be unique from other areas.

The crime rate of each city expressed as a percentage of respondents who experienced crime victimization was highest in Seoul (9.1%), where the population density is also the highest (Table 6). The next highest cities in terms of crime rate are Daegu, Gwangju, Pusan, and Ulsan, which are metropolitan cities. However, it is noteworthy that Jeju province appears to have the highest crime rate next to Seoul and Daegu even though it is not a metropolitan city. The abnormally high rate of crime in Jeju province may be explained by its characteristics as the best tourist region in Korea.

Table 6. Crime Victimization Rate of Each City

Order	City	Crime Victimization Rate (%)	Crime Victim (people)	Respondent (people)
1	Seoul*	9.1	308	3,395
2	Daegu*	8.9	136	1,521
3	Jeju**	8.4	68	812
4	Gwangju*	8.1	107	1,321
5	Pusan*	7.9	162	2,042
6	Ulsan*	7.7	86	1,111
7	Gyeonggi**	7.4	245	3,304
8	Incheon*	7.3	135	1,856
9	Jeonnam**	7.1	102	1,435
10	Daejeon*	6.9	90	1,304
11	Chungnam**	6.5	103	1,588
12	Chungbuk**	6.4	87	1,357
13	Gyeongnam**	6.4	110	1,720
14	Gangwon**	5.4	81	1,503
15	Jeonbuk**	5.4	73	1,362
16	Gyeongbuk**	5.2	97	1,871
Total		7.2	1,990	27,502
Metropolitan City(Average)		8.0	146	1,394
Provinces (Average)		6.5	107	1,661
Metropolitan city** Province				

The total average crime victimization rate was similar to the average crime victimization rate of total city and province in Gyeonggi, Incheon, Jeonnam, and Daejeon, in that order. The average crime rate in five metropolitan cities including Seoul and Pusan was 8.0, which is much higher than the average 7.2, and the average of the other nine provinces was 6.5, which is lower than the total average of 7.2.

On the other hand, the areas where the crime rate was lower than the average rate were low population density areas with

mountainous regions and relatively widely distributed such as Chungcheong, Gangwon, and Gyeongsang provinces.

3.2 Urban characteristics and crime factors

We investigated crime patterns of major cities and provinces nationwide focusing on the victims of crime. Socio-economic factors of the residential environments are considered as main cause of crime victimization since economic unstable state caused by unemployment, poverty etc bring social unrest. It is widely believed exposure to poverty is one of the main elements linked to higher crime rates. The size of the population is another main index of crime occurrences. The order in the table shows the rank of the city from the highest rate of crime victimization. Crime patterns could be affected by social composition of populations. Increasing number size of population is one of the conditions on increasing crime rate.

To determine what factors among types of properties are related to crime, various statistical data were gathered from government agencies mentioned earlier. The listed indices filtered and reached to the final stage of the analysis at 0.05 significant level of coefficient

correlation analysis from the data with crime victimization rate were categorized as socio-economic factors and demographic and structural factors as shown in table 4.

From these results, the factors that are directly related to the crime victimization rate are shown in Table 7 and Table 8 with an emphasis on significant indices within the range of 0.05 in the significance probability. Table 7 and 8 represent positive and negative correlation respectively between the urban characteristics and the crime victimization rate.

The crime rate was higher in areas that were highly urbanized such as Seoul, Pusan, and Metropolitan cities, compared with the nine provinces. When the road ratio, land ratio, population density, and unemployment ratio are higher, the crime victimization rate becomes higher. In comparison, when the area of administrative district, the ratio of agricultural, fishery, forestry, and mining workers, and the ratio of detached house are lower, the crime victimization rate becomes higher. As regards, especially, the indices of population density and the area of administrative district, there were significant differences among cities.

Table 7. Urban Characteristics and Crime Victimization Rate: Positive Correlation

City and Province	Road Ratio (%)	Order	Ratio of houseless Household (%)	Order	Household expenditure (1 unit 10,000 won)	Order	Land ratio (%)	Order	Population density (people/km ²)	Order	Unemployment ratio (%)	Order	Annual income (1 unit 10,000 won)	Order
Seoul [*]	12.40	1	47.6	1	2,643.90	1	35.67	1	16,181	1	3.8	4	3,501.40	1
Daegu [*]	5.60	6	39.4	4	2,410.50	4	8.75	5	2,780	4	3.5	6	2,873.00	6
Jeju ^{**}	4.13	7	34.8	7	2,330.40	5	2.80	9	286	10	2	13	2,756.60	9
Gwangju [*]	6.19	2	37.1	6	2,279.00	6	10.25	4	2,827	3	3.7	5	2,831.70	7
Pusan [*]	5.80	5	41.4	2	2,094.00	13	12.84	2	4,610	2	4.2	2	2,726.60	12
Ulsan [*]	3.29	9	33.3	8	2,633.00	2	3.76	8	991	8	2.8	8	3,384.00	2
Gyeonggi ^{**}	3.31	8	37.8	5	2,436.20	3	4.15	7	1,028	7	3.4	7	3,162.00	3
Incheon [*]	5.97	4	26.9	15	2,236.80	8	8.27	6	2,544	6	4.1	3	2,733.50	11
Jeonnam ^{**}	2.98	11	29.5	13	2,119.70	11	2.17	13	151	14	1.7	15	2,738.50	10
Daejeon [*]	6.10	3	39.9	3	2,204.70	9	11.00	3	2,673	5	4.3	1	2,829.40	8
Chungnam ^{**}	2.82	12	27.4	14	2,061.90	15	2.67	10	220	12	2.4	10	2,598.10	15
Chungbuk ^{**}	2.55	14	30.3	11	2,091.70	14	1.87	14	196	13	2	13	2,640.50	14
Gyeongnam ^{**}	2.78	13	32.7	10	2,186.10	10	2.21	12	290	9	2.6	9	2,925.30	5
Gangwon ^{**}	1.27	16	33.3	8	2,119.70	11	0.87	16	88	16	1.7	15	2,666.00	13
Jeonbuk ^{**}	3.08	10	29.7	12	1,927.70	16	2.37	11	221	11	2.3	11	2,491.60	16
Gyeongbuk ^{**}	1.80	15	26.1	16	2,265.90	7	1.46	15	138	15	2.2	12	2,946.10	4
Metropolitan City(Average)	6.48		37.9		2,358		12.93		4,658		3.8		2,983	
Provinces (Average)	2.75		31.3		2,171		2.29		291		2.9		2,770	

^{*} Metropolitan city ^{**} Province

Table 8. Urban Characteristics and Crime Victimization rate : Negative Correlation

City and Province	Area of administrative district (km2)	Order	Ratio of Homeowners (%)	Order	Ratio of agricultural, fishery, forestry and mining workers (%)	Order	Ratio of detached house (% , per total household)	Order	Size of residential area (pyeong)	Order
Seoul [*]	605.33	14	53.4	16	29.86	16	14	16	19	14
Daegu [*]	884.33	12	65.1	9	71.18	11	22	10	19.9	9
Jeju ^{**}	1,848.44	9	55.9	15	87.44	3	45	5	19.8	11
Gwangju [*]	501.31	16	62.7	12	67.94	13	21	11	20	8
Pusan [*]	765.1	13	59	14	63.36	15	22	9	18.4	16
Ulsan [*]	1,057.10	10	69.2	5	81.23	9	20	12	19.3	13
Gyeonggi ^{**}	10,131.69	5	59.6	13	79.83	10	16	14	19.7	12
Incheon [*]	1,002.06	11	68.1	7	70.04	12	14	15	18.6	15
Jeonnam ^{**}	12,095.06	3	67.5	8	86.92	6	64	1	20.8	5
Daejeon [*]	539.79	15	63.3	11	67.90	14	19	13	21.1	3
Chungnam ^{**}	8,599.86	6	74.6	1	84.02	8	51	2	22.2	1
Chungbuk ^{**}	7,432.40	8	72.2	2	87.18	4	41	7	21.7	2
Gyeongnam ^{**}	10,521.56	4	63.7	10	86.97	5	40	8	19.9	9
Gangwon ^{**}	16,613.19	2	68.7	6	92.81	1	45	6	20.9	4
Jeonbuk ^{**}	8,054.84	7	70.9	3	85.33	7	48	4	20.7	6
Gyeongbuk ^{**}	19,026.06	1	70.5	4	89.53	2	50	3	20.2	7
Metropolitan City(average)	765		63		64.5		19		19.5	
Province (Average)	10,480		67		86.7		44		20.7	

^{*} Metropolitan city ^{**} Province

It is important to note that contrary to the high crime victimization rate in all metropolitan cities, Daejeon city had a relatively low crime rate. In comparing the average of the cities with Daejeon (Table 6), indices related to land use, such as road ratio, land ratio, and the area of administrative district, show notably large differences. Daejeon shows typical urban characteristics of Korean cities, such as a relatively small administrative district, high land ratio, low road ratio, low ratio of detached house, and high ratio of residential area. On the other hand, it has relatively high rates of both unemployment and houseless ratio and low rates of annual income and household expenditures, when compared with other cities. Therefore, it is necessary to study other factors, besides urban environmental characteristics, to determine which distinctive characteristics of the city have effects on lowering the crime rate compared with other metropolitan cities.

It should be noted that despite not being a metropolitan city, Jeju province had a high crime victimization rate (8.5%), which is next to Seoul and Daegu city in order, whereas the average rate of other provinces is 5%. Jeju island, Korea's most famous tourist area, has a small resident population and a large floating population, suggesting that these two factors greatly influence the crime victimization rate. All other values having negative or positive correlation are similar to the values for other cities.

Tables 9 and 10 show the results of Pearson's correlation coefficients of the variables which are statistically significant with 0.05 of significance level in large coefficient order. Tables 9 and 10 are arranged so that variables having positive and negative correlations with the crime victimization rate are in descending numerical order. Analysis results showed that the road ratio

is the most significant effect on a district's crime victimization rate followed by in increasing order of the ratio of houseless household, household expenditure, land ratio, population density, unemployment ratio, and annual income. The correlation coefficient indicates how closely these indices are related to the crime victimization rate. In analyzing the correlation coefficient data shown in Table 9, the order of correlation coefficient value matches the order of significant level (p-value). Correlation coefficients of road ratio and the ratio of houseless household, that are the most closely related to the crime victimization rate, are 0.728 and 0.701 respectively. Table 10 shows the indices of the urban characteristics that are statistically significant at 0.05 level. The table illustrates a negative correlation with crime rate in ascending numerical order. As the area of an administrative district is small and the ratio of homeowners is lower, the correlation with the crime victimization rate becomes higher.

Table 9. Significance Probability and Correlation Coefficient of Urban Characteristics Indices (Positive Correlation)

Urban characteristics	Significance Probability (both sides)	Pearson's Correlation Coefficient
Road ratio	0.001	0.728
Ratio of houseless household	0.002	0.701
Household expenditure (10,000 won)	0.005	0.661
Ratio of land	0.01	0.625
Population density (people/km2)	0.017	0.588
Unemployment ratio (%)	0.029	0.546
Annual income (1unit : 10,000won)	0.049	0.499

Table 10. Significance Probability and Correlation Coefficient of Urban Characteristics Indices (Negative Correlation)

Urban characteristics	Significance Probability (both sides)	Pearson's Correlation Coefficient
Size of Administrative Units (km ²)	0.000	-0.790
Ratio of homeowners	0.003	-0.699
Ratio of agricultural, fishery, forestry and mining workers (%)	0.004	-0.673
Ratio of detached house (%)	0.013	-0.604
Size of residential area (pyeong)	0.031	-0.540

Analysis of the indices of urban characteristics listed in Tables 9 and 10 shows that most indices, such as road ratio, area of administrative district, land ratio, and population density, indicate a high urbanization ratio. Also, it is commonly observed that the ratio of houseless household and the household expenditure index increase as the urbanization ratio is higher. The unemployment ratio increases and differences in income between classes are certain to occur. Urbanization increases the ratio of apartment rather than detached house. It also lowers the size of residential area and increases the ratio of workers in secondary or tertiary industries rather than primary industries. The phenomenon that increases the crime rate as urbanization ratio is higher, was confirmed in comparing the average crime rate for Seoul, Pusan, and Metropolitan cities with the other nine provinces as shown in Tables 7 and 8.

4. RESIDENTIAL ENVIRONMENTAL ELEMENTS IMPACT ON URBAN CRIME PATTERN

We investigated the relations of crime victimization with residents' characteristics such as housing type, education, occupation, and awareness. We determined whether any crime victims among respondents were present in that year and analyzed the data statistically by employing only theft cases that cause crime victimization directly and extensively.

4.1 Housing type and crime pattern

Housing is the most basic measure to protect from crime. Opportunity theory explains a reasonable correlation of dwelling patterns with the crime rate. Living in an apartment is considered safer than living in other housing types. It is attributable to a well equipped supervisory system such as CCTVs, guards on the apartment precincts, arranging spaces by function. Therefore, the housing type is thought to be the most effective element in crime prevention. Previous researches support this assumption: Choi and Ki (1998) reported that living in an apartment proves more effective in crime prevention. Park (2011) showed that an apartment or officetel (a type of studio apartment or studio flat) has lower probability of crime victimization than detached, semidetached, or multiplex houses.

In this study, we classified the housing types as detached house, apartment house, row house, and multiplex house. From a survey of 27,502, 7.2% of respondents had experienced actual crime at home. As seen in Table 11, 8.1% of detached house residents answered that they experienced crime victimization, while 5.8% of apartment house residents, 7.9% of row house residents, and 9.0% of multiplex house residents experienced crime victimization. To analyze

whether the type of housing has a significant effect on crime in reality, the Chi-squared test was performed targeting the residents who experienced crime victimization at first. The Chi-square and its p-value are 58.46 and 0.000 respectively, indicating that there is a significant difference in crime occurrence according to housing types. Based on this result, crime occurred most frequently in multiplex houses followed by detached houses, semi detached houses, and the least in apartments.

Table 11. Crime rate according to crime frequency of housing type

Housing type	Percentage of Crime Victimization for each house type	Victims of crime(N) [*]	Respondent (people)
Detached house	8.1	1,065	13,129
Apartment house	5.8	611	10,616
Row house	7.9	180	2,276
Multiplex house	9.0	134	1,481
Total / Average	7.2	1,990	27,502
Theft (Repeated theft counted)			
Housing type	%	Number of crime occurrence ^{**}	
Detached house	6.3	863	10,953
Apartment house	3.9	430	13,719
Row house	5.4	130	2,386
Multiplex house	6.9	107	1,550
Total / Average	5.3	1530	28,608

^{*}Total number of household that crime occurred

^{**}Total number of crime counted

In terms of theft, as residential environments are key to criminal opportunity, their residents appeared to be vulnerable in the following order: multiplex house, detached house, row house, and apartment. The Chi-square statistics and its p-value are 59.71 and 0.000 respectively, indicating that there is a significant difference in the theft crime occurrence according to the housing type.

One-way Analysis of Variance (ANOVA) for different housing types was performed and the average and standard deviation for each housing type was analyzed. Subsequently, the significance probability was calculated according to One-way Analysis of Variance and the reliability was measured.

As shown in Table 12, the result of the One-way ANOVA indicates that there are differences in crime rate depending on the housing type. F, which is the difference between the averages of four housing types, this is 14.391, the p-value is 0.001 and, therefore, the result is statically significant at the level of 0.05. Since the result of the One-way ANOVA indicated that there were differences in crime rate between comparative groups depending on housing type, a post-hoc test was done to understand whether there was any difference between groups utilized. As a result of the Sheffe test, a post-hoc test, of crime numbers in relation to the housing types, the entire study subjects were divided into two large groups. One group included the apartments and row houses and the other group contained row houses, detached houses, multiplex houses, and others.

Table 12. Reliability Test

Housing type	Sum of squares	Degree of freedom	Mean square	F	Significance probability
Housing type	3.573	3	1.191	14.391	0.001
Error	2366.985	28604	0.083		
Total	2370.558	28607			

4.2 Residents’ characteristics and urban crime patterns

We have examined the socio economic and demographic environments related to crime victimization. Now we focus more on individual environments. Examining who is vulnerable to crime and on what ground of vulnerability would contribute to prevent crime by calling attention to potential targets.

The Routine Activity Theory (Cohen and Felson, 1979) suggests that the lack of ability to protect oneself and the suitable target of crime are minimum conditions of victimization together with the motivations of the criminals. Common interest is not the motivation of criminals, but protecting oneself and one’s family from victimization is. Cohen and Felson suggested that higher income and residence closeness to the central urban area are factors of high victimization of crime. Poor, African American, Hispanic, Younger, Male, lower educational background, and single are the attributes of individuals that are more vulnerable to crime of all kind in the USA (Bachman, 1994; Bastian, 1993). However, not much study has been done on relations of the crime victimization to individual factors in the domestic researches.

We applied Logistic Regression Analysis to determine whether personal characteristics such as individual housing type, education, occupation, and awareness affect the probability of crime victimization. Logistic Regression Analysis was also used to predict the possibility of future crime victimization, which determines the probability of crime by using linear combination of independent variables. Data from 47 questions were obtained from a total of 27,502 respondents. The adopted independent variables that possibly related to crime are housing type, tenant forms, marital status, education degree, occupation, education background, and job status. Using Binary Logistic Regression Analysis, which is set to the presence of crime victimization as dependent variables, it was represented in odds ratio to show how it affects crime rate depending on the difference of each dependent question. The odds ratio is the ratio of the odds of an event occurring in one group compared with the odds of it occurring in another group.

(1) Housing type and possibility of crime victimization

The various housing types, divided into apartment house, row house, multiplex house, and detached house, were analyzed for relationship with crime victimization rate (Table 13). The test of significance for all four housing types appeared to be 0.0, which is statistically significant. Given that other variables are fixed, and assuming the possibility of crime victimization for those that live in apartments (1) is 1, it shows that the odds of crime occurring in a detached house increases 1.839 times. On the other hand, a multiplex house increases 1.631 times compared with a apartment house and a row house increases 1.560 times. This can be interpreted as reflecting the level of crime prevention of other types of housing compared with the crime victimization rate of an apartment.

Table 13. The odds ratio of crime according to housing type

Housing type	Sig.	Exp (B)
Apartment	0.000	1.000
Row house	0.000	1.560
Multiplex house	0.000	1.631
Detached house	0.000	1.839

(2) Tenant forms, marital status and possibility of crime victimization

Tenant form is a reliable indicator of wealth. Considering that responsibility of home security also depends on ownership of a house, we can make the assumption that this is one of the factors of crime victimization. The tenant forms of respondents were divided into five groups: owned, leased, monthly rental with deposit, monthly rental, and free house. The result of Binary Logistic Regression Analysis for potential relationship with the crime victimization rate showed that the odds ratio increased for leased, monthly rented with deposit, monthly rented, and free use compared with house owner. However, since the test of significant level was not within 0.05, the tenant form was not applied to the indicator of the crime victimization rate.

Looking at foreign examples, marital status needs to be investigated to determine whether it affects crime victimization. Marital Status was divided into the categories of single, married with spouse, separated by death, and divorce. This was analyzed for any relationship to the crime victimization rate by Binary Logistic Regression Analysis. With referenced point of single, the probability of the case of separation by death decreases by 0.78 times at the significant level of $p \geq 0.05$. Assuming life patterns and ages of singles in Korea, there is more work to be done for acceptable explanation of this phenomenon.

Table 14. The significance test and probability of crime according to tenant form

Tenant form	Sig.	Exp (B)
Own	0.601	1.000
Lease	0.694	1.055
Monthly rent with deposit	0.872	1.023
Monthly rent	0.328	1.155
Free	0.349	1.177

Table 15. The odds ratio of crime according to marital status

Marital status	Sig	Exp (B)
Single	0.184	1.000
Married with spouse	0.209	0.832
Separation by death	0.036	0.771
Divorce	0.201	0.828

(3) Educational degree conversion and probability of crime victimization

Crime rate is inversely proportional to the educational level of the culprit. However as a point of victim, higher educational background might be considered helpful to prevent crime by avoiding exposure himself from a criminogenic environment due to awareness of various social issues. To determine if there is any connection to crime victimization with educational background, Analysis on educational degree conversion is made. Educational degree conversion is the sequence variable classified in order of elementary graduate, middle school graduate, high school graduate, college graduate, and graduate school graduate. The analysis showed that educational degree conversions were statistically significant with a p-value of 0.0, suggesting that an increase in education degree was related to crime victimization. The crime victimization possibility, compared with the elementary school graduate (1), increases approximately 1.104 times as the education degree becomes one step higher. Therefore, the possibility of experiencing crime is 1.104 times higher among middle school graduates, 1.219 times among high school graduates, 1.346 times

among college graduates, and 1.486 times among graduate school graduates, compared with elementary school graduates.

This may be explained as an education degree does not help in the prevention of crime victimization at all. On the contrary, people who are thought to be economically superior, with a high level of education may be exposed to higher risk of crime victimization.

Table 16. The odds ratio of crime victimization according to education level conversion

Education degree conversion	Sig.	Exp (B)
Education degree conversion	0.000	1.104

(4) Possibility of crime victimization according to occupation type

Occupation sometimes tells one's position in a society and degree of exposure of crime victimization. Assuming that working environments could possibly effect crime victimization, we analyzed the relationship between crime victimization and occupation types. As shown in Table 17, occupational type is classified with 10 different categories from the highest ranking professional (members of the National Assembly and senior staff).

Analysis showed that the categories of occupation directly related to the possibility of crime victimization are skilled agricultural, forestry and fishery workers, and craft and its related trade workers. The possibility of crime victimization according to this is 1.455 times higher in skilled agricultural, forestry, and fishery workers. However, it is difficult to explain the probability of crime victimization based on the occupation types since the other occupations are not on the level of significance of 0.05. Compared with the members of the National Assembly and Senior staff, only two types of occupation have an acceptable level of significance: craft and its related trade workers and skilled agricultural forestry and fishery workers.

Skilled agricultural, forestry, and fishery workers have much higher probability of victimization of crime than the groups of craft and related trade workers as well as assembly men and senior staff. Consequently, we can conclude that having considered higher occupation is more likely to be secure.

Table 17. The odds ratio of crime according to occupation

Occupation	Sig.	Exp (B)
National Assembly men, senior staffs	0.000	1.000
Crafts and related trade workers	0.001	0.629
Service workers	0.601	0.930
Technicians and associate professionals	0.839	1.032
Simple labor workers	0.523	1.078
Plant, machine, operation and assemblers	0.292	1.127
Sales workers	0.197	1.171
Office workers	0.180	1.197
Specialists	0.234	1.219
Skilled agricultural, forestry and fishery workers	0.002	1.455

(5) Status in employment

Living in an area with a higher unemployment rate signifies living in an insecure environment. However employment status of oneself could affect crime victimization as it relates with vulnerability of crime targets too. It is very likely that this directly leads to crime

victimization. The employment status is classified as regular workers, temporary workers, employees, daily workers, unpaid family workers, and self-employed. Based on the result of Logistic Regression Analysis, with the exception of self-employed and unpaid family workers, the rest showed a correlation with the crime victimization within a 0.05 significant level.

Compared with regular workers (1), the probability of crime is decreased for temporary workers, employees, and daily workers, who do not have significant difference among themselves with values of 0.22 to 0.253 times. In the case of regular workers, their exposure to the most social activities may significantly increase their possibility of crime victimization compared with workers in other categories of employment status.

Table 18. The odds ratio of crime possibility according to the status of employment

Status of workers	Significance probability	Exp (B)
Regular workers	0.000	1.000
Temporary workers	0.026	0.220
employees	0.032	0.231
Daily workers	0.043	0.253
Unpaid family workers	0.091	0.318
Self-employed	0.129	0.356

(6) Personal activities and emotion related to crime

To determine whether the human consciousness may play a role in crime victimization, the related statistical data were used. By dividing the degree of fear for crime victimization into stages (feel very much, feel some, feel a little, feel usual, not feel much, not feel at all) the relationship between each of the stages was investigated and the crime victimization rate was examined. At this time, the degree of fear was based on the first stage in sequence variables, which felt the most fear of crime victimization.

The result of Logistic Regression Analysis shows that crime victimization decreased by 0.807 times as the fear of crime decreased by one stage compared with the first stage, which felt the most fear of crime victimization. In other words, as the fear of crime increases, the more criminal victimization increases.

On the other hand, when the cases of walking alone or walking with another pedestrian at night are considered, the case of walking alone at night had the crime victimization rate 0.637 times higher than the other case.

Table 19. The odds ratio of crime victimization according to other personal factors

	Significance probability	Exp (B)
Fear for crime victimization	0.000	0.809
Walking alone at night	0.000	0.657

5. CONCLUSION

Utilizing data from a nationwide survey on welfare, safety, and environment and statistical data collected from cities and provinces in South Korea, the relationship of urban crime victimization rate with factors such as urban characteristics, personal characteristics, and housing types were analyzed. We have achieved to acquire environmental factors of cities and provinces among huge range of properties that affect urban crime throughout the examinations on nationwide scale. One of the clear distinctions of this study is the

fact that the target domain is nationwide unlike most of existing study which is based on samples of particular area on micro scaled local. By interpretations of these characteristics of cities and provinces together with patterns of crime, we can expect to predict general tendency of crime by reviewing them and to utilize any urban planning such as administrative restructurings.

First, with regard to the relationship between urban characteristics and crime victimization rate, the following factors had a correlation: population density, unemployment ratio, road ratio, land ratio, home ownership, size of residential area, annual income, household expenditure, detached house ratio, total area of city and province, and ratio of homeowner and ratio of houseless household. With higher population density, unemployment ratio, annual income, household expenditure, road ratio, land ratio, and houseless household, the crime rate increases. With lower size of residential area, ratio of detached house, total area of city and province, ratio of homeowner, and the number of homeowner, the crime victimization rate decreases.

From the analysis by individual city and province, Seoul and other metropolitan cities showed high crime victimization rate, as compared with other provinces. The provinces which have many rural and fishing villages showed a low crime victimization rate and also confirmed the phenomenon of increasing crime rate as the urbanization ratio is higher. Analysis has verified that as the population density rises, the crime victimization rate increases. Our research proves that the urban factors closely related to the degree of urbanization positively correlate with the crime victimization rate.

Secondly, a Chi-square test was performed to determine whether different housing types had a significant effect on crime occurrence. As house type is relevant to theft crime, theft crimes analyzed separately to see differences with the types of all crimes included. When analyzing the data on the housing type and crime victimization, crime occurred most frequently in multiplex houses followed by detached houses, row houses, and the least in apartments in both case. A One-way ANOVA analysis was performed to determine whether the crime victimization rate was actually differentiated by the housing types. Based on the result of a Sheffe post-hoc test by housing type, it could be seen that there were differences in the crime victimization rate between an apartment house and a detached house as well as between an apartment house and multiplex housing.

The results of these analyses showed that high-rise apartments, which have relatively superior crime prevention facilities and exclusive residential environment, make it difficult for criminals to intrude and escape. In comparison, the low-rise structure of a house have poor crime prevention facilities and are easy to break into. Therefore, the latter are relatively vulnerable to criminals. Also, multiple crime prevention features such as surveillance cameras and the triple door lock system are included in the apartments. Conversely, multiple housing and a large number of old fashioned houses are greatly exposed to crime due to relatively poor design. After all, we reconfirmed conventional theories of living in an apartment are safer for not only theft crime but also all types of crime.

Thirdly, we studied whether personal attributes have an effect on crime victimization. A probability statistical analysis shows that crime victimization could not be predicted based on tenant forms,

which were classified into 5 groups of owned, leased, monthly rent with deposit, monthly rent, and free. We also observed that the more people are educated, the probability of crime victimization rate also increases. In the analysis of occupations, only three among the ten groups were able to draw comparable results. Based on senior staff, the craft and related trade workers and service workers showed low crime probability.

Status in employment showed that the regular employees had higher probability of crime victimization rate compared with temporary workers, employers, and daily workers. Also, in terms of awareness of crime victimization among individuals, as the fear of crime increased, the crime probability increased as well. People walking at night experienced higher crime probability than people not walking at night.

The studies on what personal attributes are affect to crime victimizations of individuals were not easily found in Korea. This study revealed the personal factors that affects to crime victimizations throughout nationwide sample.

In this study, the factors of urban and local characteristics that affect crime victimization and personal characteristics that are influenced by crime occurrence were examined. However, the numerous factors relating to crime victimization as well as those presented in the above studies are scattered throughout the city. Since the relationship of these factors is interactive and complex, it makes the prediction of the crime victimization rate and crime prevention more difficult.

For this reason many studies analyzing crime occurrence from the macroscopic point of view are ongoing. However, the reality is that there are many difficulties and limitations in analyzing accurately factors that affect crime victimization. In the future, the structural relations that these factors are acting on and with each other need to be examined comprehensively.

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