Spatial Analysis of the Urban Crime for Building U-Crime Prevention Service

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ABSTRACT

Crime has been increasing two times more than 30 years ago and became serious social problem in Korea. Thus this paper intended to investigate the spatial characteristics of crime happening through the Exploratory Spatial Data Analysis (ESDA). In order to clarify the characteristics of crime occurrence by land use, overlay analysis was conducted with the crime map which contains the precise location of 5 crime types and the land-use map. Next, the study tried to find out the patterns of crime occurrence by global and local spatial level of the city.

As results, it was found that 5 type of crime is intensively located with high density in the area of commercial land use which entertaining and accommodation shops are concentrated. With the Neighbor Hierarchy Cluster and K-means Clustering method, criminal hot spots were found in global and local level. Finally, strategic implications for crime prevention were suggested. The findings are expected to promote the development in U-City by being utilized as guideline necessary for designing and developing U-Crime Prevention service.

Keywords: Spatial crime pattern, Spatial Data Analysis, Crime prevention, Ubiquitous City

1. Introduction

Our society faces serious issue of crime due to rapid industrialization and urbanization. Moreover criminals are becoming more daring in the ways they commit crimes. In order to cope with the increasing and deteriorating criminal situation, Korean government implemented sterner measures to combat crime. Among them, recently, using IT and ubiquitous technologies, effective and applicable devices and systems have been developed such as CCTV, GPS, automatic alarming system with cellular phone etc. Moreover Korea is strongly propelling Ubiquitous City and 'U-Crime Prevention Service' is one of the most popular service to be provided as Ubiquitous City Service (U-City service).[1]

However, it is more important to make better environment in urban space to prevent crime before its occurrence. Accordingly, we need to analyze the feature of crime occurring in a city and to identify the factors that affect the occurrence of crime so as to build the optimum crime prevention system and U-Crime prevention service.

Though the concern on crime has been increasing, there are not so many researches which approach crime from spatial concept. In addition it is difficult to find regional crime map which anyone can refer to at anytime and anywhere. From this, this research intended to analyze the spatial pattern of crime occurrence in the local city, Jinju City, 340,000 of population, which is alienated from crime prevention compared to large city (see Figure 1).

The result of this study is anticipated to help to reduce crime and give valuable information for developing U-Crime prevention service in Ubiquitous City.

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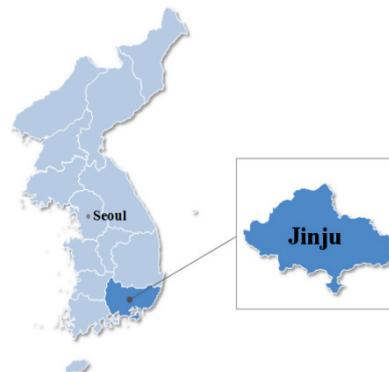+82-55-751-5324(Tel)
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2. Crime situation in Jinju City

Crime report in 2008 issued by Jinju Police Station was utilized as the dataset for analysis. It includes information such as date, dong(administrative unit in Korea) of crime occurrence, place, crime method, type of 5 main crimes, etc.

The number of total crime in Jinju City in 2008 reached 3,930 but because of obscurity on the data, only 2,362 cases are selected and marked their exact location on GIS map for spatial analysis, which took a considerable time.

These spatial data uses ArcView 3.3 and Spatial Analysist 2.0 extension of ESRI. CrimeStat 3.0. However Spatial Analyst Tools and Spatial Statistics Tools of ArcGIS 9.0 are used to analyze spatial statistics of crime data.

3. Spatial analysis of crime occurrence in Jinju City

3.1 Relation between land use and crime occurrence

It was reported that crime occurring in the cities is closely related to the land use in the area (Kim Dong Keun, et. al, 2007). Thus land use and the location map of crime incidents are overlaid as shown in Figure 2 to see whether this finding is appliable to jinju City and which characteristics exist.
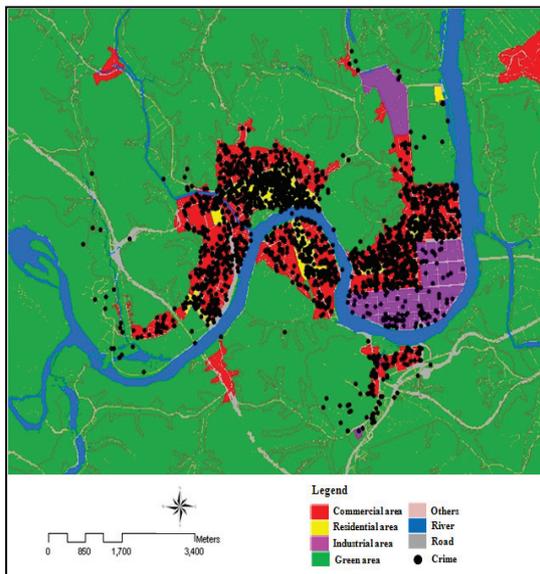
FIGURE 2. Overlay analysis of land use and 5 types of crime incidents

The 5 types of crime occurrence is analyzed to be intensively located in the area with many service establishments like entertaining and accommodating shop. Thus, the institutional improvement like limiting the permission of service business can be considered to the area with excessive rate of commercial use. As alternatives, obligatory installation of crime prevention equipment like CCTV and increasing police patrol in this area may contribute to reduce crime.

3.2 Pattern of crime occurrence in city level (global level)

Crime density was analyzed to identify the tendency of spatial crime occurrence in the whole area of Jinju City. Methodologically, after the research area was divided into grids, the frequency of each point, crime location, in the grid was counted. Then, Kernel estimation method was applied, which can discover the distributed pattern of points in 2-dimensional space. Giving higher weight to the neighbor point, Kernel method analyzes the tendency of occurrence in adjacent place. However it is important to set the bandwith in determining weights on distance between points. In accordance with theory, researcher should control them properly in consideration of data structure of case city. However in this case, the bandwith was set in 300m.

The result shown in Figure 3 reveals that the crime was distributed in group in whole area of Jinju City. In the figure, the thicker color refers to high density of crime occurrence. The areas of highest crime density appear in Seongji-dong, Gangnam-dong, Bongan-dong adjacent to Jungang-dong and Chilam-dong. As commercial area in downtown, these areas have high moving population. Chilam-dong is area where youngsters move actively until late time due to the inter-regional bus terminal and Jinju National University.
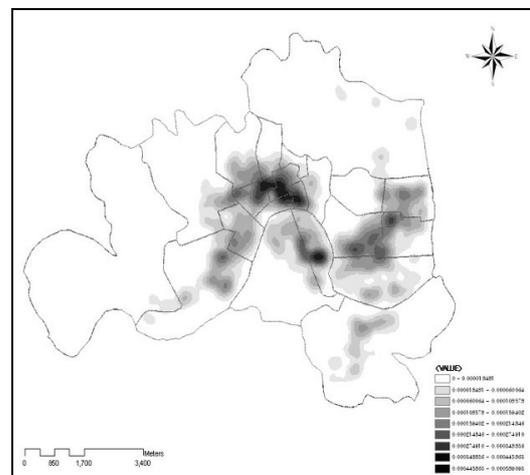
FIGURE 3. Analysis of crime density by Kernel estimation method

The spatial crime distribution analyzed by crime density can be presented in more quantified index through the nearest analysis. Theoretically, analysis can be made by using Nearest Neighbor Index (NNI) as the rate between the average value of nearest distance, $\overline{r_a}$, among the points observed in formula 1 and the expected value, $\overline{r_e}$, in formula 2.

$$\overline{r_a} = \sum_i \min d_i \qquad (1)$$
$$\overline{r_e} = 1/2\sqrt{n/A} \qquad (2)$$

d_i: distance between point i and the nearest point
n: number of points, A: area of grid

NNI, 1 refers to complete random distribution type and NNI larger than 1 means regular distribution. However NNI below 1 means collective distribution.

In the case of Jinju City, the NNI of total crime is 0.44, showing high collective pattern. In the types of crime, violence reveals the most collective pattern in 0.43 and homicide, 0.56, relatively collective occurrence (see Table 1). While homicide is generally known to have random distribution, it is analyzed to belong to high collective pattern in this research. However, since the number of homicides is low in this research, it is somewhat difficult to draw final conclusion.

TABLE 1. Nearest Neighbor Index (NNI) by criminal type

Crime	NNI	Z Score
Total	0.44	-51.1
Murder	0.56	-1.5
Robbery	0.63	-2.7
Rape	0.45	-5.2
Thief	0.46	-36.8
Violence	0.43	-34

3.3 Pattern of crime occurrence in local level

The pattern of crime occurrence in whole city level (global level) is subject to the limit that different result may be drawn depending on the spatial scope of analysis area. Thus, it is important to find criminal cluster that occurs as crime is locally, not globally, concentrated in the relation with adjacent area. To this end, the Nearest Neighbor Hierarchy Cluster (NNHC) method was applied.
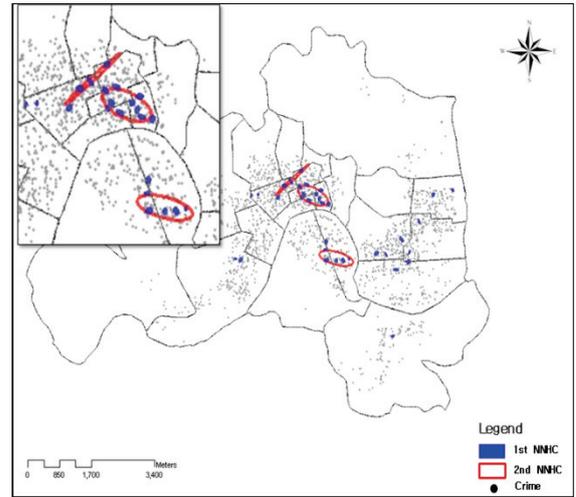

FIGURE 4. Analysis of crime occurrence by NNHC method

Analyzing the nearest cluster in the case area, as shown in Figure 4 and Table 2, the 1st cluster was found in Jungang-dong, Seongji-dong, Bongan-dong, Chilam-dong and Sangdae 1-dong and the 2nd cluster was confirmed in the civic center including Jungang-dong, Seongji-dong, Bongan-dong, and Gangnam area including Manggyeong-dong and Chilam-dong. Being adjacent to traditional market like Jungang market, department store, bus terminal and street without car, the civic center is one of the areas of high moving population. Another 2nd crime cluster, Gangnam area, is characterized as very complicated land use due to Jinju Station, express bus terminal and educational facilities like college and institutes.
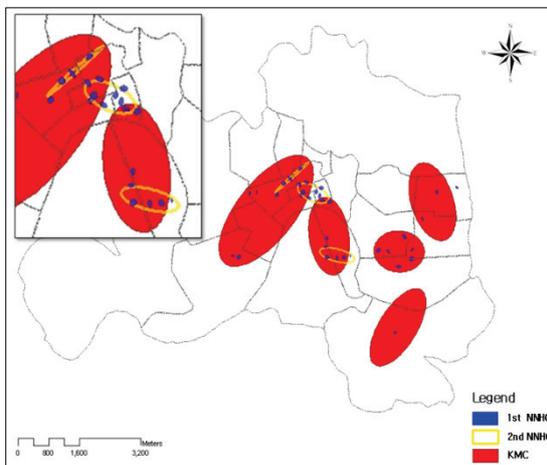
TABLE 2. Number of Nearest Neighbor Hierarchy Cluster (NNHC)

Area	1st NNHC	2nd NNHC
Jungang-dong, Seongji-dong, Bongan-dong	17	2
Manggyeong-dong, Chilam-dong	6	1
Sangdae-dong, Hadae-dong, Sangpyeong-dong	9	-
Pyeonggeo-dong	2	-
Gaho-dong	1	-

Next, K-mean Clustering (KMC) method was introduced to find another cluster of crime in local level.
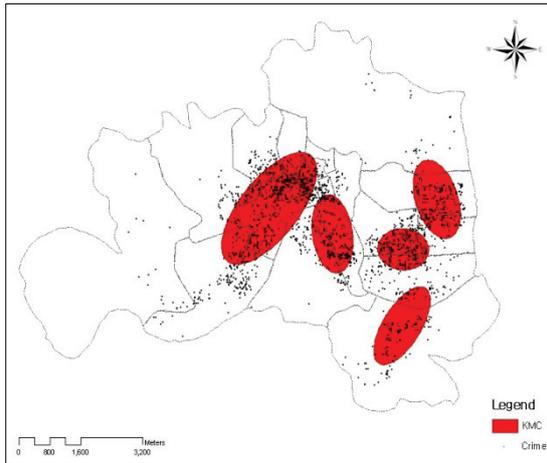
FIGURE 5. Hot spots of crime driven by KMC

FIGURE 6. Analysis of hot spot by KMC and NNHC

As shown in Figure 5, the cluster where crime is concentrated locally is found in the central area (Jungang-dong, Seongji-dong, Sinan-dong, Gangnam-dong, Bongan-dong), and some parts of Pyeonggeo area (Sinan-dong), Gangnam area (Chilam-dong, Manggyeong-dong) and Sangpyeong area (Sangdae-dong, Gaho-dong). Meanwhile, overlaying the 5 clusters by KMC and 3 clusters by NNHC, Figure 6 shows that 3 K-means clusters coincide with the 1st clusters of NNHC.

4. Conclusion

This research analyzed the spatial distribution pattern of 5 main crime incidents in Jinju City. Then, the followings were found. Firstly, crime intensively occurred at the place where service facilities such as entertaining shops and accommodation shops are densely located in the area that is designated as commercial area. Thus, it may be necessary to arrange the law of city planning such as

limiting the rate of service shops foundation in the area where the rate of commercial uses is too high.

Furthermore, crime may be reduced if obligatorily installing equipment that can prevent and monitor crime like CCTV in these areas and enhancing the police patrols. Regional crime map accessible on the web can be a good guardian for citizen to identify the dangerous place and to prepare against crime when they visit the place.

Finally, even in this study, the crime rates as the relevant research could be known to have close relationship with spatial conditions. Moreover it was possible to analyze the pattern of local crime occurrence. Accordingly, the strategic approach can be known to be important in order to understand spatial attribute in urban space, to establish a security plan of reflecting regional characteristics such as hot spots. Especially, this study offered important issue to implementing U-Crime Prevention service that is being expanded the demand in U-City project, which is being driven nationally. It is expected to come to probably promote the development in U-City by being utilized as guideline necessary for designing and developing U-Crime Prevention service.

Acknowledgements

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