

Analysis of the Spatiotemporal Distribution and Influencing Factors of Victims with Different Characteristics in Theft Crime: A Case Study of Baoan District of Shenzhen City

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Abstract

This study takes Bao'an District, Shenzhen as the study area and analyzes the environmental factors affecting the distribution of theft crime victims among residents with different characteristics from the perspectives of built environment and social environment variables. The research results indicate that variables such as the proportion of juveniles, the proportion of the floating population, scientific and cultural facilities, and road network density all have a certain impact on the victimization of residents with different characteristics. Based on these findings, the paper proposes targeted prevention and control measures, including strengthening security patrols in areas frequently visited by women, paying attention to areas where non-local residents congregate, enhancing education and management for juveniles, improving community policing, increasing surveillance in key areas, and conducting safety awareness campaigns, to reduce the risk of theft crimes and protect the lives and property of the public.

Keywords

Victim Characteristics; Theft Crime; Poisson Regression; Influencing Factors.

1. Introduction

In today's information age, the integration of GIS (Geographic Information System) and big data has brought revolutionary changes to the field of crime analysis. Big data GIS not only promotes the industrial upgrading of traditional GIS technology, but also demonstrates powerful capabilities in processing and analyzing massive spatial data, which is particularly important for crime analysis. Its application in public security work, such as case investigation, crime prevention, precise strikes, and auxiliary decision-making, has significantly improved the level of informatization, intelligence, and intelligence in police work. The rational choice theory^[1] states that criminals will weigh the benefits and possible costs of committing a crime during the process. When the benefits of the crime exceed the costs, the criminal's willingness to commit the crime will be strengthened^[2]. Among them, the benefits and potential costs of crime are strongly related to the characteristics of the criminal target, especially some external features of the criminal target may strengthen, induce, and promote the generation of criminal motives^[3]. Therefore, exploring the temporal patterns and spatial distribution of victims with different characteristics is of great significance for crime prevention and police patrols.

In the context of urbanization, theft and other property related crimes have become one of the important issues affecting urban safety. These criminal activities not only directly infringe upon the property rights and interests of the people, but also have a serious impact on social order and public psychology. With the expansion of urban scale and the increase of population mobility, the spatial and temporal distribution characteristics of criminal activities have become more complex and varied. On the one hand, bustling commercial areas, transportation

hubs, and densely populated residential areas have become high-risk areas for crime; On the other hand, the time distribution of criminal activities also shows a certain regularity, such as an increase in crime rates during nighttime, holidays, and other periods. Urbanization not only brings economic prosperity and population concentration, but also exacerbates social conflicts and security risks. Especially among residents with different characteristics, due to differences in economic status, social status, lifestyle, living environment, and safety awareness, the mechanisms by which they suffer from theft crimes are significantly different. Residents with poor economic conditions and lower social status are often more vulnerable due to a lack of sufficient prevention capabilities and living in areas with poor public security; The differences in lifestyle, behavioral habits, living environment, and inadequate safety awareness and skills further exacerbate this inequality. Therefore, in-depth analysis of the spatiotemporal distribution characteristics of theft crimes in the process of urbanization and their correlation with residents with different characteristics is of great significance for formulating effective crime prevention and governance strategies, ensuring the safety of people's lives and property, and promoting the harmonious and stable development of cities. In the field of crime analysis and research, Jiang Mingjun conducted a simple statistical analysis on the age and gender of victims in Shenzhen's electronic fraud cases, and found that female victims accounted for 51.6%, male victims accounted for 48.4%, and the average age of victims was 29.75 years old^[4]; Zhang Yaowen et al. used statistical methods to study the age and gender characteristics of victims of telecommunications fraud in different regions. They found that the proportion of male victims in Northeast China who experienced identity fraud was lower, while it was higher in East China. There were significant differences in the characteristics of victims of telecommunications network fraud in different geographical spaces^[5]; Qu Jia used cross analysis to find significant differences in variables such as victim age and the value of property lost by victims in street pickpocketing cases in Beijing. Female victims were mainly concentrated in public transportation and alleys, while male victims were mainly concentrated in public transportation^[6]; Powers pointed out that the racial heterogeneity, population distribution, existing social structure, and awareness of criminals and victims are related^[7]. Local populations are more familiar with the urban environment where they live and have a higher use of public transportation, so they are more likely to be victimized by crimes in places with convenient transportation and a larger population than migrant populations^[8]. From the above research, it can be seen that current studies on the victimization of crime victims focus more on general statistical analysis of victim characteristics, or analyzing the reasons for victimization of victims with different characteristics in specific environmental scenarios^[9], while lacking research on the characteristics of victimization locations of residents with different characteristics from a spatiotemporal perspective, especially the quantitative analysis of the distribution of victimization locations of residents with different characteristics based on various environmental variables. Therefore, this paper chooses the theft case as the research object, and tries to study the space-time distribution of the victim sites of residents with different characteristics from the perspective of the victim's gender, registered residence and age characteristics, and analyze the spatial distribution of the victim sites and their environmental impact factors in combination with the built environment and social environment.

2. Study Area and Data

2.1. Study area

Bao'an District of Shenzhen City is one of the nine municipal districts of Shenzhen City, which, as shown in Figure 1, contains 138 communities with a total area of 396.69 square kilometers (Source: 2015 Statistical Yearbook of Shenzhen City (sz.gov.cn)). The Sixth Population Census of

2010 showed that the total population of Bao'an District totaled about 4,499,000 people, of which about 2,504,000 were male (about 55.65% of the total population) and about 1,995,000 were female (about 44.35% of the total population) (Data source: Shenzhen Municipal Bureau of Statistics (<https://opendata.sz.gov.cn>)).



Figure 1. Schematic diagram of communities in Bao'an District, Shenzhen, China

2.2. Research Data

The dependent variable of this article comes from the 110 theft crime alarm data of Shenzhen Public Security Bureau from January 1, 2013 to December 31, 2015. After noise removal and manual cleaning of the data, a total of 9495 theft crimes containing victim characteristics were obtained for analysis. Extract independent variables from POI (Point of Interest) data, road network data, and social environment data. Among them, the POI data of Shenzhen city is obtained through GaoDe Map (interface address: <https://lbs.amap.com/api/webservice/guide/api/search>) A total of 21 types of POI data were obtained. Based on the research content and the interrelationships between variables in this article, after screening and merging, there are still 8 types of POI including scenic spots, shopping malls, and entertainment facilities, totaling more than 130000. The data on road network density and social environment comes from the website of Shenzhen Bureau of Statistics (interface address: <https://opendata.sz.gov.cn>).

2.3. Poisson regression

In this paper, we use the method of Poisson regression^{[10][11]} to construct a spatio-temporal association analysis model for Bao'an District with the community as a unit, using the spatial distribution data of the victimization sites of residents with different characteristics in each community in Bao'an District as the dependent variable, and using the micro-social environment data and the micro-built environment data as the independent variables for the correlation factor mining. The model is as follows:

$$\ln(\lambda_i) = \beta + \sum_k^K \beta_k x_{ik} + \varepsilon_i, k = 1, 2, \dots, K \quad (1)$$

where λ_i is the occurrence statistics within each buffer zone; n denotes different buffer zones; i denotes the type of crime; k denotes different POI types, and x_{ik} denotes the vector of the number of various types of POI in the buffer zones; ε_i is the random error term; and the regression coefficient β_k is the relationship between the POI and crime. Compared to the Poisson regression model, the negative binomial regression model adds the estimation of the residual term considering that the residuals obey a Gamma distribution, which improves the fit to over-discrete data:

$$\varepsilon \sim \text{Gamma}\left(\frac{1}{\alpha}, \alpha\right), \alpha > 0 \quad (2)$$

where α is the variance parameter (scatter parameter) of the Gamma distribution. The value of α is determined by the Likelihood Ratio Test (LR), if α tends to 0, it indicates that the Poisson regression model is more suitable for fitting the data; if α is significantly greater than 0, it indicates that the negative binomial regression model is more suitable for fitting the data.

3. Findings

In order to explore the influencing factors of residents with different characteristics, social environment and built environment, the number of people in each community with different gender, registered residence and age is regarded as the dependent variable. In this paper, the K-S Test method (Kolmogorov Smirnov test) is used to test the data. The results show that the p-value corresponding to theft is less than 0.001, and the R2 value of Poisson regression is more than 0.5, so the Poisson regression model is used. The cross-correlation analysis values of the 12 selected variables do not exceed 0.3, the VIF values are all less than 5, and the VIF mean is less than 3, indicating weak collinearity of the independent variables and reasonable selection of model indicators. The regression results are shown in Table 1.

(1) In the social environment, the ratio of male to female population is significantly negatively correlated with the victim areas of residents with different characteristics, indicating that the higher the male population, the lower the crime rate; There is a significant positive correlation between the migrant population and the victimized areas of residents of different genders, and between the victimized areas of residents of different registered residence and different ages only for residents from other places and young people. This indicates that the higher the crime rate in communities with more migrant population, the greater the impact on residents from other places and young people, which may be due to the social integration, economic status and living conditions of the migrant population; The proportion of adolescent population is significantly positively correlated with the locations where residents with different characteristics are victimized, indicating that the more adolescents there are, the higher the probability of community theft. This may be due to a portion of the adolescent population participating in criminal activities for various social reasons.

(2) In the built environment, residential services, leisure and entertainment, scenic spots, shopping places, and road network density show a significant positive correlation with the victim areas of residents with different characteristics. This indicates that communities with more facilities in these places have higher theft crime rates, which may be due to the large population flow in these areas, providing more opportunities for crime; There is a significant negative correlation between government agencies and medical institutions and the affected areas of residents with different characteristics, which may indicate that communities with more government agencies and medical services have lower crime rates. The reason may be that government agencies have stronger legal enforcement and regulatory capabilities in their areas, and the accessibility of medical services may improve residents' sense of security and

quality of life, thereby reducing crime rates. The impact of science, education, and cultural facilities on different groups varies. There is a significant positive correlation between science, education, and cultural facilities and the locations where young people and elderly residents are victimized. This indicates that the higher the community theft crime rate of science, education, and cultural facilities, the more likely it is that young people attend classes at school and elderly people pick up and drop off their children, thus creating opportunities for crime; There is a significant negative correlation between science, education, culture, and the location of male residents' victimization, indicating that communities with more science, education, and culture have a lower risk of victimization for male residents. This may be because male residents are less likely than female residents to pick up and drop off their children to school, reducing their victimization risk in these areas.

Table 1. Poisson Regression Results

independent variable		Theft crime						
		Male victim	Female victim	Local victim	Non-local victim	Teenage victim	middle-aged victim	elderly victim
Socio-environmental variables	Male/female ratio	-0.05***	-0.170***	-0.172***	-0.183***	-0.391***	-0.439***	-0.363***
	Mobile/permanent population ratio	0.140***	0.380***	0.353	0.234***	0.386***	0.442	0.150
	Proportion of adolescent population	0.120***	0.30***	0.425***	0.438***	0.551***	0.786***	0.126***
Build environment variables	Company	0.140***	0.157*	0.358***	0.358***	0.421***	0.395***	0.213
	Recreation & Entertainment	0.341**	0.704**	0.382***	0.397***	0.326***	0.341***	0.236***
	residential services	0.279***	0.358***	0.350***	0.348***	0.325***	0.278**	-0.142
	scenic spot	0.046***	0.189***	0.120***	0.0369*	0.311***	0.226**	0.316**
	Shopping Services	0.386***	0.445***	0.124**	0.343***	0.376***	0.484***	0.525*
	government organs	-0.228***	-0.204***	-0.184	-0.104**	-0.187***	-0.144*	-0.178
	Science, education, and culture	-0.356**	0.114	-0.312	-0.423	0.188**	-0.149	0.328**
	Medical Service	-0.142***	-0.348***	-0.394***	-0.343***	-0.341***	-0.105**	-0.493**
	Road network density	0.253***	0.209***	0.230*	0.038*	0.211***	0.313***	0.313*
N		138	138	138	138	138	138	138
R ²		0.569	0.523	0.513	0.612	0.558	0.543	0.549

4. Summary

4.1. Suggestions

(1) Establish targeted prevention strategies for specific populations. Enhance police patrols and increase monitoring equipment in shopping areas where women are frequently active, in order to improve regional security in these areas; For the issue of out of town residents being easily victimized, government agencies should provide more information and support to help them better integrate into the community and reduce the possibility of becoming targets; Strengthen safety management in school places where teenagers and elderly residents frequently engage in activities, improve the security and prevention system around the campus, and carry out student safety education.

(2) Targeted publicity and education should be conducted for specific target populations and high-risk areas. Through media and public propaganda, raise public awareness of theft crimes, especially the special victim risks of residents with different characteristics. For example, self-protection education can be carried out for women to raise their awareness of potential crime risks and vulnerable places (such as shopping places). Post more promotional slogans in

commercial areas, residential areas, and areas with dense road networks to carry out warning propaganda and enhance the awareness of prevention among the local residents.

(3) Strengthen the use of big data technology and GIS. Using big data technology to integrate multi-source data, utilizing data mining techniques to uncover hidden patterns in crime data, and utilizing GIS to identify and focus on monitoring and patrolling crime hotspots.

Acknowledgements

4.2. Conclusion

This article is based on theft crime alarm data and POI data in Shenzhen, and uses GIS and big data technology to analyze the spatiotemporal patterns of different characteristic residential victim sites, as well as the influencing factors between different characteristic residential victim sites and social and built environments. The results indicate that residents with different characteristics in Shenzhen are more likely to be victimized in terms of time and spatial distribution, with males, non locals, and adolescents being more likely to be victimized. The analysis of the influencing factors of different characteristics of residents' victimized areas in Shenzhen found that the social environment and built environment have a certain impact on them, and there are similarities and differences among them. The research and utilization of big data technology and GIS can provide certain references for crime prevention and police patrols of public security organs, and promote social harmony and stability.

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