International Journal of Urban Sciences

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rjus20

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To cite this article: Yi-Kai Juan & Wan-Hsuan Lin (2023) The relationship between residential burglaries and urban environments in Taipei City: a data mining approach, International Journal of Urban Sciences, 27:1, 155-177, DOI: 10.1080/12265934.2022.2085151

To link to this article: https://doi.org/10.1080/12265934.2022.2085151

INTERNATIONAL JOURNAL OF URBAN SCIENCES
2023, VOL. 27, NO. 1, 155–177
https://doi.org/10.1080/12265934.2022.2085151

The relationship between residential burglaries and urban environments in Taipei City: a data mining approach

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ABSTRACT

Although the overall crime rate in Taiwan has shown a declining trend in recent years, the proportion of burglaries remains high. Most studies regarding the prevention of burglaries proceed from the perspectives of population composition or criminal psychology, and place focus on the internal spatial planning of buildings without mentioning the association between case locations and urban environments. In order to effectively prevent crime and improve the quality of life, this study utilized cases provided by the *Taipei City Government Open Platform (Data. Taipei)* to confirm the surrounding environmental factors and building data of burglary cases for data mining application. The proposed method consists of two phases: clustering and association rule mining. In the clustering phase, the key substructures of environmental information are collected; then characteristics in each cluster are analyzed based on the association rule. The results of analysis showed that the first group (Group 1) in the classification should give priority to improving the visibility of idle space and streets, while the second group (Group 2) should improve the efficiency of personnel surveillance and solve the problem of crowds caused by business activities. The third group (Group 3), which featured narrow lanes and insufficient street lamps on chaotic streets, should engage in overall planning and design. Some studies have found that the environmental characteristics of burglary cases in Taipei City are different from the characteristics of crime-saddled urban areas defined by international scholars. Such differences deserve further study. The findings of this study can serve as an environmental design model for future urban development.

ARTICLE HISTORY
Received 2 March 2021
Accepted 4 May 2022

KEYWORDS
Residential burglary; government open data platform; data mining; clustering; association rule; Taipei City

Highlights

- Develop the environmental influencing factors of burglary cases in Taipei City.
- Retrieve 495 burglary cases provided by the Taipei City Government Open Platform.
- Apply data mining techniques to analyze environmental factors of burglary cases.
- Identify different association rules for three clustering groups of burglary cases.
- Explore implications of residential burglary and urban environmental design principles.

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1. Introduction

The issue of 'safe city' has received wider attention in recent years. Since the *Economist Intelligence Unit* published the list of the 'safest cities in the world' in 2015, many countries around the world have been proactively formulating policies to prevent burglaries, hoping to improve environmental quality through design and even disclosing data regarding crime hotspots and transparent public security information (Davies, 2015; VanEijk, 2020).

Following this trend, Taiwan has also been promoting its open information policy as a part of open government. The Taipei City government launched *Data. Taipei* in 2011, an open data platform. Later, the crime database management system was established in 2015 to map out crime hotspots and disclose information related to residential burglary locations. The public has been encouraged to use this system to increase their awareness of residential safety.

Many scholars have conducted research on preventing burglaries. Wu et al. (2015) adopted space syntax to analyze street networks and population composition, and found that road connectivity, education, and unemployment rates are significantly related to the risk of burglary. Sohn (2016a) indicated that whether burglary is rampant in an area is significantly related to the diversity of land use, traffic density, and street connectivity, and that better environmental design could prevent crime. Amiri, Brooks, Vila, and Daratha (2019) analyzed the surveillance of building openings and found that buildings with poorer surveillance are more likely to be intruded. Socioeconomic factors and time may also fuel crime. However, as shown above, studies on the prevention of burglary have been mostly based on social factors, space control, the overall environment, or only on the internal planning of buildings.

In order to put the concept of safe city into practice, this study reviewed domestic and international literature, along with the data released by *Data. Taipei* and police statistics, and explored the relationship between the surrounding environment and houses prone to burglary. It also transformed the data into burglary factors in line with Taiwan's environment. The association rule analysis used in data mining techniques was applied to explore the correlation among burglary factors. A number of implications of urban burglary prevention and environmental design principles were also discussed.

2. Literature review: impacts of environmental design on urban burglaries

2.1. Environmental design and crime prevention theories

The method of crime prevention was first proposed by Jacobs (1961) in *The Death and Life of Great American Cities*, in which she stated that crime prevention does not hinge solely on the policy. Environmental design, clear boundaries between public and private areas, the natural surveillance effect of buildings facing the streets, and the utilization rate of streets can provide residents with a good vision of how to prevent the entry of suspicious personnel and create a safe living environment. The term *Crime Prevention Through Environmental Design* (CPTED) was coined by Jeffery (Jeffery, 1969; Weiner & Jeffery, 1979). He used CPTED and extended Jacobs' method by calling for appropriate design, environmental improvement and maintenance, community activeness and participation, and police-civil defense systems to enhance natural surveillance that could

ease the fear of residents and reduce urban crime rates. *The Defensible Space Theory* of Newman (1972) proposed four indicators for crime prevention: (1) surveillance, which refers to providing good visibility by means of architectural design and configuration of the surroundings, such as doors and windows, lighting, and traffic penetration, thereby promoting neighbourhood alertness and prevent intruders from committing crimes; (2) territoriality, which refers to perfecting the division of public and private spaces, clearly defining regional ownership, and facilitating surveillance and management among residents; (3) image, which refers to establishing the positive image of a residential area or building so as to improve the overall residential environment and make the area less prone to crimes; and (4) milieu, which refers to constructing residential buildings in a safe urban environment with good surveillance to prevent the intrusion of criminals.

The *Routine Activity Theory* (RAT), proposed by Cohen and Felson (1979), proceeds from the offender, and holds that current social activities provide offenders with an opportunity to commit crimes. The occurrence of crime requires three conditions: the motivated offender, the suitable target, and the lack of capable guardianship. The most effective preventive strategy is to avoid the integration of the three elements into the living environment, thus making the surveillance effect an important element of crime prevention (Brantingham & Brantingham, 1993). Cornish and Clarke (1986) proposed the *Rational Choice Theory* (RCT) to support the concept of the RAT in criminology. The RCT assumes that participation in criminal activity is the result of a rational decision-making process by which the costs and benefits associated with crime are consciously weighed. An individual may decide to participate in criminal activity if the benefits of crime are determined to be greater than its costs. Clarke (1997) proposed the *Situational Crime Prevention* (SCP), which uses various interventions, intimidation, or preventive measures (e.g. installing surveillance systems or security screens in vandalized areas) to reduce potential risks and prevent crimes. On the other hand, Brantingham and Brantingham (1993) proposed the *Crime Pattern Theory* (CPT), also known as the *Crime Search Theory*. Similar to the RAT, the CPT uses the main components of the built and social environment—activity nodes, paths between nodes, neighbourhoods and neighbourhood edges, and the socio-economic backcloth—combined with the routine movements of the general population to determine where crimes frequently occur and understand the formation of repeat areas of offense for individuals and groups of offenders, as well as the aggregate crime hot spots and cold spots.

Many scholars have used the crime prevention theory as a research index of urban environmental improvement, and numerous studies have confirmed the effectiveness of the theory. Environmental design and planning can effectively prevent burglaries. Residential areas farther away from urban centres should improve the effect of natural surveillance, while residential buildings in urban centres should reduce the permeability of traffic routes, as more convenient traffic increases the chances of offenders' intrusion. The application of such methods in different cities and locations should vary according to the urban development pattern, and architectural and environmental factors should be taken into consideration for crime prevention (DeBiasi, 2017; Foster, Giles-Corti, & Knuiman, 2011; Hirschfield, Birkin, Brunsdon, Malleson, & Newton, 2014; Marzbali, Abdullah, Razak, & Tilaki, 2012; Peeters & VanderBeken, 2017).

2.2. Residential burglary

According to the statistics of the National Police Agency in Taiwan, the most direct impact on public security is burglary, including the burglary of houses, public facilities, vehicle components, agricultural, fishery, and animal husbandry products, and cables, among which the proportion of residential burglary is the highest. For example, in Taiwan, the total number of residential burglary cases in 2017 was 4,409. There were 32.46 burglary cases per 100,000 individuals, taking up 57.67% of all burglary cases relating to citizens nationwide. With the development of urbanization and the establishment of high-rise buildings, old buildings and lands often lack proper management and maintenance, thus giving offenders more opportunities to commit crime (Ajayakumar & Shook, 2020; vanSoomeren, 2013). Taipei City has set a good example for urban crime prevention in Taiwan. Recent years have seen the disclosure of information such as burglary intensity, with the aim of raising residents' alertness and improving living quality. However, according to government statistics, there were still as many as 505 cases of residential burglary in Taipei City in 2017, indicating that there is still considerable room for improvement in crime prevention.

Urban safety exerts the most direct impact on residents. Urban planning and design, possibly including the use of street layouts, buildings, road spaces, landscape planting, and residential planning, are crucial to creating a safer environment. All these measures aim to enhance the overall surveillance and effectively prevent the intrusion of criminals (Amiri et al., 2019; Foster, Hooper, Knuiman, Bull, & Giles-Corti, 2016). Characteristics of residential burglary that are more distinct from general crime events include the followings:

- Residential burglars often target specific urban and building environments to commit crimes (Townsley et al., 2015; Langton & Steenbeek, 2017; Peeters & VanderBeken, 2017). In other words, the external built environments have a higher correlation with residential burglary cases.
- Residential burglars are less likely to have random motives. They typically conduct multiple surveys and investigate nearby shelters, terrain, and escape routes for assessment before committing the crimes (Nee & Meenaghan, 2006). That is, residential burglars are often repeat offenders and have some predictability.
- The purpose of residential burglary is to steal valuable objects without being exposed or harming people, and without the need of sophisticated criminal tools (Cohen & Felson, 1979). Therefore, the time and place of the crime, and the possibility of being exposed to surveillance, may also affect the motives of crime.

Compared to other types of crime, residential burglary is more likely to occur in specific urban and building environment characteristics. This inference also confirms that factors related to environmental design, such as surrounding environments, terrain, surveillance, and escape routes, are effective in preventing residential burglary (Bernasco & Luykx, 2003; Vilalta, Sanchez, & Fondevila, 2021).