



Bicycle parking security and built environments

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ABSTRACT

The lack of secure bicycle parking is a serious but often neglected issue that discourages bicycling. Classical environment criminology theories try to explain the pattern of bicycle theft but provide limited insights into the relationship between crime and the built environment. This study examines the association between built environment factors and bicycle theft using a zero-inflated negative binomial model to account for data over-dispersion and excess zeros. The assembled dataset provides variables pertaining to the road network, land use, bicycle travel demand, and socio-demographics. The key findings are as follows: (1) Bicycle theft is more likely to occur in areas for commercial purposes, areas with a high population or employment density, and areas with more bike lanes or sidewalks. (2) Bicycle theft is likely to occur at sites with more bike racks or bus stops. (3) Bicycle theft is more likely to occur at mid-blocks than at intersections. (4) Bicycle theft is more likely to occur in neighborhoods with a greater percentage of socially disadvantaged people and in neighborhoods where residents' median age is lower. (5) The likelihood of losing a bicycle is lower in areas with more bicycle trips. In general, the number of bicycle thefts increases in dense areas with more targets and decreases with greater natural guardianship provided by more passersby. With respect to policy implications, governments and transport planners should implement a geographically-differentiated surveillance strategy, encourage bicycling, improve the visibility of bike racks to the public, and promote surveillance and natural guardianship in densely developed areas.

1. Introduction

The bicycling rate continues to increase in the United States (US), creating great potential to improve public health and mitigate environmental challenges while simultaneously encouraging physical activity. However, as the bicycling rate increases, so does the number of bicycle thefts (Sidebottom et al., 2009). Existing research provides profound insights into how to encourage bicycle use through policy interventions, infrastructure provisions, educational programs, and roadway safety improvements. Nevertheless, many people do not consider bicycling a primary transportation mode. This is partially due to a lack of secure storage at destinations, which leaves unattended bicycles vulnerable to damage or theft. Although bicycle theft generates relatively small impacts on communities, its negative effects on bicycle use cannot be overlooked.

In the US, bike rack shortages in some areas result in undesirable parking practices. For example, bicycles may be locked on trees, fences, telephone poles, road signs, and streetlights. These undesirable practices result in damaged trees or congested and obstacle-ridden sidewalks. Although bicycle parking guidelines have been proposed by national and local authorities, these guidelines mostly

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focus on bike rack design, lock choice, and site planning. The connection between the location of bike racks and secure parking environments has not been adequately addressed (Association of pedestrian and bicycle professionals, 2002; US Department of Transportation and Federal Highway Administration, 2006). The question of how to utilize planning strategies to prevent bicycle theft remains unanswered.

It is a long-standing convention that urban designers search for effective design methods to prevent crimes in the micro environment (Jacobs, 1961; Jeffery, 1977; Newman, 1972). The interdisciplinary field known as environmental criminology was developed to investigate criminal patterns and their relationship to the physical characteristics of the built environment and their vulnerability to criminal activity (Andresen, 2014; López and Nes, 2007). Existing environmental criminology studies mostly focus on bus stop robbery, theft from cars, and residential burglary (Kim et al., 2007; López and Nes, 2007; Loukaitou-Sideris et al., 2001), whereas bicycle theft has rarely been investigated.

The factors that contribute to bicycle theft may include insufficient bike racks, a lack of surveillance, and high crime rates (Gamman et al., 2004). Thus, distributing bike racks, promoting surveillance of parked bicycles, and identifying secure locations for better-planned bicycle parking are key components in securing bicycles. Better bicycle parking security contributes to the increased popularity of bicycling (Fukuda and Morichi, 2007; Sidebottom et al., 2009; Van Lierop et al., 2015). Therefore, transportation planners should provide alternative approaches to bicycle security by identifying the environmental features of secure bicycle parking.

This study conducts an analysis in the city of Seattle, where bicycling is more popular than in other US cities. The local municipality has made a serious commitment to promoting infrastructures that accommodate the needs of bicyclists. The remainder of this paper is organized as follows. After a review of the literature on related theories, the relationship between bicycle theft and the urban environment, and management experience, the description of the data and the research design are presented, followed by the data summary and modeling outcomes. The paper ends with conclusions and policy recommendations.

2. Literature review

2.1. Related theories

2.1.1. Environmental criminology and crime pattern theory

Environmental criminology is a discipline that investigates various degrees of adjacency, permeability, and inter-visibility at different scales, all of which contribute to crime opportunities in urban space (López and Nes, 2007). Crime prevention through environmental design provides a set of strategies that are used to reduce crimes and improve quality of life through 'the proper design and the effective use of the built environment' (Cozens, 2008; Cozens et al., 2015; Fisher et al., 2016).

There are several schools of environmental criminology theory, such as Routine Activity Theory and Crime Pattern Theory (Andresen, 2014; López and Nes, 2007). Routine Activity Theory makes two assumptions for a criminal event (Andresen, 2014; López and Nes, 2007). First, there are at least three elements of a successful crime, including an offender, a target, and a lack of guardianship. Second, illegal acts are fed, in part, by the recurrent and prevalent activities of daily life. Routine activities influence criminal opportunities and create predictable situations (Andresen, 2014; López and Nes, 2007). Crime Pattern Theory explains why crimes occur in certain areas by assuming that crimes are not random; rather, crimes are either planned or opportunistic. Crimes occur within the activity space of an offender (López and Nes, 2007). Although this theory postulates where offenses occur and connects crime with the built environment, it provides few insights into how to improve environmental quality through urban design.

2.1.2. Urban design theory with the element of crime

Classical urban design theories also emphasize crime prevention through environmental design. In *The Death and Life of Great American Cities*, Jane Jacobs identified three critical principles of a secure built environment: 'there must be a clear demarcation between what is public space and what is private space; there must be eyes upon the street; the sidewalk must have users on it fairly continuously, both to add to the number of effective eyes on the street and to induce the people in buildings along the street to watch the sidewalks in sufficient numbers' (Cozens et al., 2015; Jacobs, 1961; Minnerly and Lim, 2005). In short, these principles promote a naturally shaped mutual guardianship among individuals in the public space. Using a framework that correlated environmental design and crime, Oscar Newman concluded that certain environmental features correlate with the rates of various crimes, as discussed in *Defensible Space: Crime Prevention Through Urban Design* (Cozens et al., 2015; Minnerly and Lim, 2005; Newman, 1972). Some general findings are as follows: crimes are more likely to occur in high-rise blocks, and crimes are facilitated by a low level of surveillance and the presence of internal corridors and accessible exits. More recent research has used advanced quantitative methods, such as space syntax, hotspot analysis, and regression models, to correlate crime with the built environment for better environmental design (Adel et al., 2016; Barnum et al., 2017; López and Nes, 2007; Sohn, 2016; Wilcox et al., 2003). Existing studies tend to focus on crimes that occur near bars, gas stations, bus stops, grocery stores, schools, playgrounds, and parks (Barnum et al., 2017; Drawve et al., 2016; Matthews et al., 2010).

2.2. Bicycle theft and the urban environment

2.2.1. Bicycle theft

Bicycle theft is considered a type of frequent vehicle-related property offense. Bicycles are far more likely to be stolen (4.7%) than cars (1.2%) and motorcycles (1.9%) (Johnson et al., 2008b). From the perspective of law enforcement, bicycle theft is not a high

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