EXPLORING THE RELATIONSHIP BETWEEN ENVIRONMENTAL DESIGN AND CRIME:
A CASE STUDY OF THE GONZAGA UNIVERSITY DISTRICT

By
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Abstract
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Most people never consider that physical characteristics can be altered to prevent crimes, but there is a growing body of evidence showing that crimes are not randomly distributed and can indeed be connected with certain environmental factors. The intent of this thesis is to understand the linkage between the design and management of the physical environment and crime prevention. This paper explores their connection by reviewing the five environmental crime prevention theories, including Jacobs’s “Eyes on the street,” Newman’s “Defensible Space,” Appleton’s Prospect-Refuge Theory, Crowe’s Crime Prevention Through Environmental Theory and Hillier’s Space Syntax Theory. Most of these theories asserted that lighting, vegetation, building design, public video surveillance, fences and signs can achieve forms of surveillance and enhance territorial identity as well as increase perception of safety. A number of studies focused on concern with the relationship between crime and physical elements. However, few studies have pursued the evaluation of whether and how these physical characteristics are effective, as asserted by the five theories.

For the purposes of this research, 11 physical factors are examined in and around Gonzaga University, Spokane, Washington. 31 zones are divided by blocks in the study area. The on-site rating standards for these factors are selected based on the tenets of five environmental crime prevention theories. The study focuses on assault, burglary, theft, and robbery crime. The actual
crime records are collected from Spokane Police Department for the period 2/1/2005 to 4/30/2010. Usage of the correlation coefficient statistic, the correlations of environmental factors and actual crimes are examined. This research supports some of the tenets of previous environmental theories and studies. A major finding of this work is shrubbery, the orientation of the building and flood light have impact on crimes. Other factors, including street lighting, tree, window bar, fence and sign have little impact on crimes. The effectiveness of CCTV, the number of building entrance and deadbolt lock with crimes are uncertain.
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1.1 Research Intent

Crime has always been a problem for the general public in the United States, and fear of becoming a victim continues to be a major concern. The United States has the highest rate of violence in the world (Currie, 1985), with homicides “from four to twelve times higher than in other countries” (Bureau of Justice Statistics, 1992). In 1990, 2.3 million Americans reported that they had been victims of violent crime (Loukoaitou-Sideris, 1999). Even though experts assure us that crime rates have actually declined over the last few years, studies show that fear of crime among the general public is still running high (Loukoaitou-Sideris, 1999). Especially in inner city neighborhoods, crime and fear of crime dictates the lives of citizens (Leavitt & Loukaitou-Sideris, 1995). No matter how much people strengthen their home or business security systems, the crime still exists and in fact is even increasing. Therefore, environmental design is being examined as a way of bringing about a fundamental turn for crime prevention. Because many citizens have a similar perception of the environment, regardless of what cultural similarities/difference they share with people from different cultures occupying their same neighborhood, they often identify their surroundings as being associated with a feeling of vulnerability in urban space engendered by its strangeness.

This research supports the view that crimes can be reduced with well-thought-out design which is intimately associated with the physical environment. Most theories on crime prevention focus on the linkage between crime and physical environmental factors. Jacobs (1961) believed that well-oriented buildings facing toward the streets, clearly delineated public and private areas, and intensive use of street space could reduce residential crime. Newman (1972) elaborated the
idea of defensible space and its most important elements of territoriality and natural surveillance. He asserted that the use of real or symbolic barriers can clearly define territoriality and that the proper use of materials and good architectural design can help to improve security in an area. Later, Jeffery and other criminologists improved the concept of defensible space, providing the theoretical groundings for the development of Crime Prevention Through Environmental Design (CPTED). Based on defensible space theory, the concept of CPTED was to alter the physical and spatial features, such as site elements (landscaping, outdoor seating and planters, fences, gates, and walls) and architectural elements (orientation of building, windows and doors) to reduce the possibility of crime. Appleton (1975) and Nasar and Jones (1992) believed that a place can be perceived as being safer by adjusting the layout and reducing its concealments and obstacles for better visibility. More recently, space syntax methodology has been used by Hillier and Hanson (1984) to examine the relationship between the occurrence of criminal events and spatial configuration. Hillier (1988) proposed that an “intelligible deformed grid” of the street layout of lower crime rate and buildings should be “constituted [of] outward facing block” for better natural surveillance. Clearly, a variety of different theories have explored the relationship between crime and environmental elements such as buildings, vegetation and lighting, etc.

This research intends to investigate the relationship between environmental settings and the outdoor crime events in and around a campus environment, specifically, the Gonzaga University campus in Spokane, Washington. The features of the environment in crime event locations can be explained and supported or opposed by crime prevention techniques through environmental design theories. The findings of this research are expected to reinforce that vulnerability and crime incidence have a significant relationship with the physical environment. Thus, the environment-crime issues can be examined in a more thorough way; therefore, better crime
prevention strategies will be proposed to deal with this issue.

1.2 Research Questions

This study is specifically about the connection of crime and the urban environment. It seeks to answer several questions: What environmental factors in the urban layout affect the incidence of crime? What are the differences or similarities in theories of crime prevention through environmental design?

1.3 Expected Research Outcomes

My research and its results will provide several contributions, including:

- Identification of possible environmental elements affecting the occurrences of crime on an urban campus.
- Provision of a reference evaluating environment-crime issues for design professionals, including architecture, urban planning and landscape architecture students.
- Affirmation or denial of the relationship between crime occurrences and environmental factors posited as being important in the various theories through an empirical analysis of the Gonzaga University area.
CHAPTER TWO
UNDERSTANDING CRIME AND PHYSICAL ENVIRONMENT

2.1 Introduction

The definition of “crime” is neither clear nor compelling. Citizens may have different understandings about what constitutes criminal activity. Generally, the definition of crime has legal and social meanings. In the legal sense, crime is a behavior or mistake that violates the law, and which imposes a range of punishments including fines, imprisonment or death. In the social sense, crime is an act or incident of negligence that jeopardizes the general welfare, interests and that is legally forbidden. Considering these differences of meanings, Siegel (2001, p.32) offers an integrated definition of crime:

> Crime is a violation of societal rules of behavior as interpreted and expressed by a criminal legal code created by people holding social and political power. Individuals who violate these rules are subject to sanctions by state authority, social stigma, and loss of status.

Crime is often regarded as one of the most serious urban problems in the United States. According to federal figures, nearly eleven million Americans experience violent crimes and about 37 million incidents occur each year (Bureau of Justice Statistics, 1997). Victims of crime suffer injuries, financial loss, and fear. The decline of quality of life, which includes social, political, and economic factors is influenced by the increasing incidences of crime. Insecurity tends to be an everyday experience for people living or working in high crime areas. This experience can seriously affect mental and physical health.

2.2 Types of Crime

Crime is a term that relates to several behaviors and actions. In the book *Economics of Social Issues* (Sharp, Register, & Grimes, 2008), criminal acts are classified as violent crimes, crimes
against property, traffic in illegal goods and services, and other crimes. Violent crimes indicate
criminal acts directed at an individual. These acts include murder, rape, robbery, and violent and
sexual assault. Crimes against property usually refer to nonviolent crimes such as fraud, burglary,
thief, embezzlement, forgery, arson, and vandalism. Traffic in illegal goods and services are the
prohibited dealings within gambling, prostitution, narcotics, loan-sharking and alcohol. The
category of “other crimes” includes a catchall for everything from nonpayment of alimony to
speeding (Sharp, Register, & Grimes, 2008).

This research only considers violent crimes (such as aggravated assault and robbery) and
property crimes (such as burglary and theft), concentrating on the urban environment. There are
other forms of crime, such as organized crime, that could not be considered in this research
which is focused on environmental crime prevention.

2.3 Causes of Crime

Crime is a complex phenomenon that occurs when a suitable target, a motivated offender, and
the absence of a capable guardian must all converge at one time in a specific place (Cohen &
Felson, 1979). For example, to measure a street crime, it is necessary to consider several factors
including the capable guardians, the motivations of offenders, potential targets, and
environmental conditions.

The offender is an important component of criminal activity. There are a number of possible
reasons behind a person who intends to commit offences. Psychological factors, such as
unrestrained passions or emotions, have the greatest impacts on crime occurrences which lead to
violent crimes. Occasionally, criminals may commit offences on impulse, out of rage or fear. In
such cases, for example, rapists push aside the constraints of moral norms and punishments to
commit crime when their emotions run high. Other offenders believe that their criminal activities can bring greater reward, excitement, and satisfaction, at least before they are caught. Accordingly criminals, especially organized ones, decide to commit crime after carefully planning everything so as to increase gain and reduce risks of failure.

Economic factors, such as poverty, appear to play an important role in shaping trends in property crime. People who are poor or suffering economic stress have the most motivation to commit crimes in order to get what they need or desire through stealing, robbing and other illegal activities. They are also assumed to commit violent crimes so as to express their anger and frustration against the society. On the contrary, crime rates drop when the poor are provided with economic opportunities via welfare and public assistance (Hannon & Defronzo, 1998).

Social factors also have various effects on potential criminal activities of individuals. The social effects of racial heterogeneity, age and gender have contributed to the relationship between social class and crime. Racial difference is an extremely sensitive issue in reference to the crime rate. After conducting a number of studies related to community racial composition and violent crime, social ecologist Robert J. Sampson discovered that districts with a higher proportion of African American residents tend to have higher level of violent crime than other racial and economic groups (Lersch, 2004). In addition, income inequality, unemployment rates, education, neighborhood disorganization and family disruption are closely tied to race, all of which strongly impact crime and delinquency.

Most of the impact on the legacy of racism, discrimination on personality and behavior, subcultural adaptations and social disorganization influence crime (Siegel, 2001). Studies have investigated the impact of family structure on crime and delinquency, noting that there is a strong tie between family disruption and rates of violent crime (Lersch, 2004). For example, someone
growing up in a poor and broken family, thus possibly being undereducated, may find it difficult to get a decent job. The resulting level of frustration over this individual’s future, in this case, could drive the possibility of gaining social prosperity through illegal activities.

Without a potential victim or the target, crime would not occur. According to the routine activities theory, targets are crime-specific. For example, for sexual assault, a suitable target must be vulnerable enough to exclude any guardianship; for burglary, it could be a low-occupancy building. There are four main factors that make targets more attractive from the offenders’ perspectives, which include value, inertia, visibility and access (Greene, 2006). Typically, offenders prefer to commit crimes that demand the least effort and that result in the highest gains, while taking the lowest risks. Items such as purses, MP3 players and other small portable possessions with a high value exemplify these principles. Inertia (referring to the size or weight of the item) can affect how suitable it is for theft. If a thief witnesses someone counting money in front of the ATM on a deserted street, the offender has the advantage of visibility. He or she has seen the money and knows exactly where it is placed. Moreover, the fact that the victim is standing alone without any guardians provides easy accessibility for the offender to make an attempt to attack without being noticed.

A capable guardian could discourage crime from taking place. Some guardians are formal and deliberate, such as security guards, door staff, locks, fences, barriers, alarm systems, Close Circuit Television (CCTV) systems, Emergency Blue Light Phones, or architecture and landscape planning/design; some are informal and inadvertent, such as passers-by or neighbors.

Thus, when these three conditions come together in a certain time and place, crime has the most possibility to happen. For example, if a man leaves his iPhone in his pocket (a suitable target) while he is taking a nap on a park bench (absence of a capable guardian) in a high-crime
park (pool of motivated offender), then it is highly probable that the cell phone will be stolen.

2.4 Environmental Criminology

Traditional criminology solely studies the origins of the offender’s criminal propensity. The most influential theories in traditional criminology are crime strain, cultural deviance, and social control theories. These theories mainly concentrate on factors such as social disorganization, personality, or inadequate parenting. However, environmental criminology has been developed across a number of disciplines, including economics, sociology, psychology, victimology and geography (Lersch, 2004). Environmental criminology involves studying other elements of criminal events, including geographic distributions of crime, analysis of crime location and target selection of offenders.

Environmental criminologists are concerned with the place and time of crime occurrences. They investigate land use, traffic patterns, and routine activities of offenders. They assume that some criminals are motivated and that crimes occur in particular situations. They also consider that rational offenders may weigh the opportunity cost and the expected incarceration time if they are arrested; such offenders are likely to evaluate the circumstances of a potential crime site, and the availability and visibility of any nearby natural guardians. By studying the time and the space where potential crime may occur, the spatial pattern of crimes and the target selection of offenders can be discovered.

Criminal events are most likely to occur in areas where the activity space of offenders overlaps with the activity space of potential victims/targets (Brantingham & Brantingham, 1991). The spatial distribution of crime is not random. It is mostly clustered around the home of offenders, the places they visit or work, and the routes they travel. Offenders may know the
ordinary schedule during which their targets are absent from their personal properties, and the locations of these properties. For example, household burglars would like to break into expensive houses close to their place in the daytime, when most residents are going out to work. Criminals know how prevailing routine activities bring together different mixes of street users at various times of the day (López & Nes, 2007). The timing of work, shopping and recreation creates regular patterns of human behavior, as well as regular patterns in criminal opportunity and the spatial and temporal behavior of criminal offenders (López & Nes, 2007). Criminals always choose the areas they are familiar with and try to make themselves not too identifiable. Sites that are heavily concentrated with crimes are described as “nodes” or “hot spots.” Moreover, it is more likely that crimes will occur in a public area (around retail stores, restaurants, bars and parking lots) as a result of a high degree of population density the area, including potential victims and motivated offenders (Savage & Souris, 2008).

2.5 Perception of Crime and Physical Environment

Physical environment has long been thought to be intimately associated with the risk of crime. Environmental criminologists have noticed that people will be more fearful of crime in particular situations. The findings show that narrow walkways without any escape routes, hidden spaces created by corners, tall bushes, and the presence of threatening individuals generate fear (Nasar, Fisher, & Grannis, 1993). Other studies have documented that fears are higher among females, especially after dark (Nasar, Fisher, & Grannis, 1993). Lighting is another element that can influence fear of crime (Hanyu, 1997). According to Goffman (1971), there are five senses including smell, sound, sight, touch and pressure to assist humans in perceiving danger in the surrounding environment. He also argues that sight is the main sense of the five which helps us
perceive our surroundings, though the others also play a role in our perceptions of and interactions to our environment at all times. Previous research indicates that several other factors are important in affecting the perception of safety in landscapes. They include: more lighting (45.4%), more (visible) security personnel (18.2%), reduced hiding places/shrubs (15.2%), and a variety of other features, including better transportation, better signs, maps of the well-lit areas and fewer vehicles (18.2%) (Nasar & Jones, 1997). In short, crime is not randomly distributed, and the physical environment can affect feelings of personal safety.

Although fear does not always reflect actual occurrences of crime, physical environment features (such as dark hiding places) can still provide opportunities for rational offenders to commit a crime. Certain areas of a community suffer higher crime rates than others because successful crime activities in these areas are environmentally conditional (Jones & Fanek, 1997). In addition, different kinds of crime may occur in particular situations. For example, pickpockets prefer to choose places with high densities of pedestrians, while burglars favor places with few pedestrians. Some studies have explored the relationship between physical environment and actual crime locations. A research of bus stop crime associated with environmental features in Los Angeles revealed “desolation and lack of surveillance”, “crowding”, “broken windows”, and “easy escapes” as significant factors for high incident of crime (Loukoaitou-Sideris, 1999).

2.6 Crime Prevention

Crime prevention is the anticipation, recognition, and appraisal of a crime risk and the initiation of some action to remove or reduce it (National Crime Prevention Institute, 1986). In order to make crime prevention effective, the risk of apprehension should be increased, presenting an unattractive target and reducing the opportunities for victimization.
Many solutions, such as tighter security, tougher criminal laws and stiffer imprisonment have been employed to deter criminal activities. Whether these approaches can solve the problem and if police will have the ability of crime prevention is, however, questionable. Felson (1998) believes that the actual time that a patrol officer can devote to guarding one’s home against crime is minimal. It is estimated that fewer than 1% of criminal offenders are “caught in the act” by a patrol officer who happens to be driving through a neighborhood at the right place and the right time (Lersch, 2004). Guardians may not have a chance to present efficiently. Staff or security members might be present in a shopping mall, but they may not have received enough training or recognition to deter crime.

Offenders, targets, and the absence of capable guardians together may form a triangle relationship for a crime to occur. But if one of these conditions is modified, it could prevent a crime from happening or at least reduce its occurrence. As a result, there are basically two ways to prevent crime and delinquency. One way is to reduce criminals’ propensity to offend. An approach from social control theory assumes that the propensity to offend depends on the individual's degree of self-control and social bonds to conventional society (Gottfredson & Hirschi, 1990). High self-control and strong social bonds can reduce the chance for offending. The other way is to reduce the presence of crime situations. The recommendations of environmental crime prevention are somehow related to altering the situation to make criminal activities more difficult and risky, and the target less attractive for attack by a motivated offender. Some of these “target hardening” approaches are on a small scale, such as adding more streetlights and installing more windows in houses that face toward the street. Other methods are on a large scale and involve planning models for buildings, communities, and entire cities under the driving principle of improving guardianship and reducing opportunities for criminal activities.
(Lersch, 2004).

This paper seeks to identify the environmental factors that can affect the incidence of crime. These multi-disciplinary approaches to prevent criminal behavior through environmental design tend to fall into five related groups: “Eyes on the Street”, Defensible Space, Prospect-Refuge Theory, Crime Prevention through Environmental Design and Space Syntax Theory.
CHAPTER THREE

THEORIES OF CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

3.1 Introduction

In the 1960s, crime prevention through environmental design started to emerge with Jane Jacobs's *The Death and Life of Great American Cities*. Jacobs (1961) stressed that some areas have higher crime rates than others because of their poor planning design. Her work reshaped the ways that urban planners and architects thought about urban problems, such as that neighborhoods should be isolated from each other and that an empty street is safer than a crowded street. Then in the 1970s, a surge of theories was developed for modifying the public environment to prevent crime, most noticeably Jeffery's Crime Prevention Through Environmental Design (CPTED) and Newman’s Defensible Space. The basic idea of CPTED was that careful design of physical environments can produce behavioral effects and reduce possible incidence and fear of crime, thereby improving quality of life and enhancing profitability for business. Defensible Space theory addressed the relationship between space design and crime in public housing environments. In ensuing years, researchers questioned and amplified Newman’s findings, and finally modified and improved the strategies of CPTED. Similar to the idea of CPTED and, particularly, the relationship between environments and fear of crime, Appleton (1975) asserted that the features of the physical environment were known to convey signals of threat or safety. Appleton first introduced prospect-refuge theory as an explanation of human environmental preferences. He believed that a certain amount of prospect (open view) and refuge (concealment, protection) in the environment offered an evolutionary advantage to humans (Appleton, 1975). Fisher and Nasar (1995) investigated several case studies of “hot spots” to support Appleton’s notion. Later, in the 1980s, Bill Hillier (1988) reinterpreted
the understanding of “surveillance”, realizing the constant while increasing movement of population across different spaces. The higher the level of liquidity and egalitarian traffic and pedestrian flow can perform, the greater the safety exists. To sum up, various theories have explored the relationship of crime and environmental safety. In this chapter, the major concepts of these theories with various results are explained and compared.

3.2 Literature Review

3.2.1 Jacobs’s “Eyes on the Street”

In *The Death and Life of Great American Cities*, Jacobs explained how to design a safe and well-used space. Drawing upon her observations of some major cities, especially the Greenwich Village area of New York City, Jacobs argued that mixed-use and dense neighborhoods could reduce the level of crime and disorder, and improve the quality of urban life. She stressed that the safety of public space should be enforced not only by simply deploying police power, but by the unconscious network of voluntary controls and standards among the citizens themselves (Jacobs, 1961). In her book, Jacobs put forward the concept of “eyes on the streets” for real crime prevention. She argued that a lively street is safer when a sufficient number of people use it and watch the street out of their windows. A lively street also has an impact on the safety of other urban structures such as parks, neighborhoods and economy.

Specifically, Jacobs discussed in depth four qualities that are critical to the healthy development of a city: mixed primary uses, short blocks, aged buildings, and high density of residents. She also listed several attributes needed to make a safe neighborhood: 1) Pathways should provide a clear boundary between public space and private space. In public areas, people should expect to see strangers; in private areas, strangers would be identified and monitored; 2) Buildings must be
facing toward the sidewalk and lining the street. These buildings provide windows and porches that keep a clear view of the streets and surroundings; 3) The sidewalk should have a good level of continuous use during both days and nights. People prefer to watch a lively street. Having more people using the sidewalk at various hours throughout the whole day enhances greater surveillance of the area; 4) A mixed primary use of the neighborhood can encourage everyone to use and guard the public space. “Stores, bars and restaurants work in several different and complex ways to abet sidewalk safety” (Jacobs, 1961, p. 36). That means people can spend time in an area that presents a mixture of businesses, residences, and cultural heritage, museums or libraries, for example. Well-used and vibrant environments are the best natural prevention against potential criminals; 5) Leisure parks and childhood playground designs create a secure and open area near sidewalks and streets. Residents, strangers, and shop keepers who happen to be walking by can easily notice and correct inappropriate behavior of others, especially keeping an eye on the children who are playing in the vicinity; 6) Most blocks must be short. Short blocks provide more navigation options for people to walk. These distributions of the pedestrian traffic become more even and create more possible locations for diverse business opportunities; 7) The installation of sufficient lighting helps increase the range of view, offering safety reassurance to people who wish to use the sidewalk at night even when they are horrified by reported public crimes.

In summary, Jacobs felt that architecture, landscape design and the urban planning would have an impact on the shaping of physical environment as well as governing and ordering the behavior of different people. “Eyes on the Street” is the positive and visual effect of the existence of local residents who interact with each other, and thus maintain liveliness and serenity in their neighborhood. Moreover, potential offenders may perceive a strong feeling of being noticed by
local residents and decide not to commit a crime.

3.2.2 Newman’s Defensible Space

Newman first made a research-based case in his book *Defensible Space: Crime Prevention Through Urban Design* to prove that site configuration and building design can be defended against potential crime and fear of crime. The term 'defensible space' refers to a residential environment designed in order to allow and encourage residents themselves to supervise and be seen by outsiders as responsible for their neighborhoods (National Crime Prevention Institute, 1986). Newman questioned the effectiveness of police control and stressed the important role of informal community control for crime prevention. He also felt that the physical environment should be redesigned in order to strengthen the perception of ownership and to encourage guardianship by legitimate users (Lersch, 2004). Although Newman’s defensible space theory was mostly focused on public housing sites, he came up with four crucial factors of physical design relevant to different kinds of projects: territoriality, natural surveillance, image and milieu.

1. Territoriality. The meaning of territoriality is defined as “the capacity of the physical environment to create perceived zones of territorial influence: mechanisms for the subdivision and articulation of areas of the residential environment intended to reinforce inhabitants in their ability to assume territorial attitudes and prerogatives (Newman, 1972, p. 50).” Newman considered human beings as territorial animals who perceive areas and spaces as their own. Places would be likely to be protected and defended if the inhabitants felt their own space was intruded upon. Thus, people defend their proprietary “ownership” of public or semi-public space through usage, maintenance and surveillance.

Newman proposed a number of practical design suggestions that serve to reduce anonymity and
increase the sense of territorial by demarcating the zones of influence. To subdivide a public space by creating paths and recreational areas outside private apartment units can establish residents’ concern and responsibility with the activity taking place and clearly indicate that inappropriate users will not be allowed. To restrict vehicle movement and access of streets design can enhance a form of continuous natural surveillance, as well as formal police patrol. Also, a visual cue or boundary can indicate the zones of transition from public to private space. With a proper design, the construction of real and symbolic barriers was found to increase the sense of territoriality. Real barriers included high walls, fences, locked gates and doors. Symbolic barriers included such things as open gateways, lighting, and changes in the texture of the walkways, a short distance of steps, or the use of plantings (Newman, 1972).

2. Natural surveillance. Newman (1972) defined the concept of natural surveillance as the “capacity of the physical design to provide surveillance opportunities” (p. 50). A building with good surveillance opportunities, with the entrance faced by many apartment windows and being visible from a busy street, would reduce feelings of fear for the residents. The residents can easily view public areas and make motivated offenders aware that areas are being watched.

In order to enhance natural surveillance, Newman argued that buildings should be oriented in such a manner that there is a well-lit lobby area in front of the buildings from which the residents can easily observe the outside street. As an example, Newman tested three categories of buildings in relation to a street in a Bronx, New York housing project. He found that the places where all buildings were facing within 50 feet of the street and with good lobby visibility had less crime than those with fewer buildings facing the street and without any lobby visibility. Additionally, Newman indicated that fire escapes, windows, floor plans, and roof landings could all be altered to enhance the ability of residents to monitor activities and thereby discourage
crime (Lersch, 2004).

3. Image and milieu. Newman felt that the image of environment conveys a sense of security. Most high-rise public housing projects were designed to be very visually identifiable from the surrounding community. The low income housing projects that used cheaper materials on the facades and lack of outdoor balconies may allow easy invasion. To reduce crime, Newman argued that lower-income housing projects should be designed in such a manner that they better fit in with the surrounding buildings. In the spirit of Jacobs, Newman felt that housing projects built in commercial and industrial areas with intense vehicular and pedestrian movement were generally viewed as being safe as a result of the high value of “eyes on the streets.” However, Newman suggested that the placement of commercial and institutional facility projects must be critically evaluated in accordance with the nature of the business, the hours of operation, the intended users of the business, and the identification with area residents, the periods of human activity, and the presence of concerned authorities. Not all institutional and commercial areas can automatically enhance the safety of surrounding neighborhood. Some bored teenagers may hang around schools and pool halls, for example; the existence of such public and commercial establishments may increase the level of criminal activity in the neighboring areas. So, the concept of site choice and site configuration is crucial for assuring the security of the surrounding neighborhood.

3.2.3 Crime Prevention Through Environmental Design

Crime prevention through environmental design (CPTED) is centered on the notion of Newman’s Defensible Space. Jeffery was the first to use this phrase as the title for his book. Jeffery’s theory was based on the idea that the current crime control policies being used were
ineffective. He argued that the best way to reduce crime was to directly organize environmental conditions prior to the punishment for an offense. Briefly, Jeffery stresses the importance of creating a sense of territoriosity among residents, and providing natural surveillance through environmental design. In recent years, Wilson and Kelling (1982), Taylor (1997), and Crowe (2000) redeveloped and popularized CPTED as a socio-physical perspective to emphasize that design-affects-crime. According to Crowe (2000, p. 34), the design principle of CPTED was that “the physical environment can be manipulated to produce behavioral effects that will reduce the incidence and fear of crime thereby improving the quality of life. These behavioral effects can be accomplished by reducing the propensity of the physical environment to support criminal behavior.” CPTED is based on three strategies for physical design programs that overlap in their practical use, including access control, surveillance and territorial reinforcement.

1. Access control. Access control is a CPTED concept focused on limiting opportunities for a motivated offender by denying access to potential targets. When a potential target is perceived as being hard to get access to, then the offender may give up taking the risk or move on to a different target. Access control strategies usually include informal/natural (e.g. spatial definition), formal/organized (e.g. security guards) and mechanical (e.g. locks and key-pad entry system or swiping identification cards before access). In a well-designed space with good natural access control, limiting the number of entrances or exits can prevent unauthorized access to buildings and restricted interior areas. In communities, natural access may involve using fewer through streets as access routes and, instead, relying on more cul-de-sacs and dead end streets to limit traffic flow (Crowe, 2000).

2. Surveillance. Surveillance is a design concept aimed at keeping potential offenders under easy observation. Proper location and use of design features and activities may create a perception of
increased risk of detection for offenders and of increased safety for legitimate users. Different types of surveillance are typically classified as natural (e.g. windows and lobbies that enhance the monitoring of the outside streets; carefully placed park benches; well designed landscaping), organized (e.g. police patrols) and mechanical (e.g. street lighting and CCTV).

3. Territoriality. The concept of territoriality suggests that physical design can contribute to a sense of territoriality (Crowe, 2000). Legitimate users develop a sense of ownership, thereby reducing the opportunities for potential offenders. The use of physical features can express territorial influence and delineate public, public-private and private spaces. Different forms include symbolic barriers (e.g. signs and pavement treatments) and real barriers (e.g. fences or low walls, landscaping and artwork) which promote territorial behavior and proprietary concern for space, in addition to promoting opportunities for surveillance. Natural access control and surveillance will also contribute to a sense of territoriality by promoting legitimate users’ informal social control and greater perception of risk by offenders.

Another strategy called the “broken windows” theory was added to CPTED (Kelling & Coles, 1996). The theory states that when a building is left with a broken window, graffiti, trash, etc., a few more windows could be broken by vandals. The situation may get worse while the building is unoccupied, and vandals may even break into it. Therefore, properties should be well maintained to ensure the continued use of space for the proper purpose and to increase the sense of safety for users. For instance, trees and shrubs should be trimmed, and litter and trash should be picked up on time. In addition, it should be ensured that exterior lighting works properly at night.

3.2.4 Prospect-Refuge Theory
Although Jacobs (1961), Newman (1972) and Jeffery (1971) mentioned that territoriality and natural surveillance can reduce the opportunity for potential offenders, there is still slack of studies showing how the offenders consider or use the physical arrangements. Appleton's Prospect and Refuge Theory (1975) explained that prospect and refuge provide the greatest opportunities to "see without being seen", which is related to the ability to evade predators but locate prey. The prospect was clarified as an unimpeded opportunity to see and the refuge was considered as an opportunity for the creature to hide. The ability to see and the ability to hide are important to calculate a creature’s survival prospects and to satisfy many biological needs. The theory postulated that the capacity of an environment becomes a more immediate source of aesthetic satisfaction because of the ability to “see without being seen”. Besides, Appleton (1975) argued that “a landscape which affords both a good opportunity to see and a good opportunity to hide is aesthetically more satisfying than one which affords neither, but again weakness in prospect or in refuge may be compensated for by strength in the other (p.74)”.

Fisher and Nasar (1992) also considered that concealment, prospect and escape are key physical measures for offenders to commit crime. Concealment refers to specific locations or areas that can conceal a criminal outside of the line of sight, produce uncertainty, and limit an individual’s ability to escape a threatening situation (Nasar, Fisher, & Grannis, 1993). Thus, criminals seek places where there is a lack of surveillance and they try to avoid people watching them. Research suggests that offenders prefer places that afford them concealment from which to view the situation and enough prospects to maintain control over a situation (Archea, 1985). Furthermore, criminals may favor spots that have limited escape routes for victims, but favor spots that provide an easy escape to run away after they commit a crime. Fisher and Nasar’s (1992) further study on the campus of Ohio State University was highly supportive of the Prospect-Refuge
theory. It was shown that design can be used to reduce the fear of crime as well as to provide opportunities. This study developed a survey that asked graduate students of landscape architecture, planning and design to rate eight test areas including measure of prospect, refuge and escape. The results partially confirm the hypothesis that fear is higher in locations that offer good refuge for the potential offender, but low prospect and escape for the user. In other words, the feeling of safety was in relation to the proximate environment reduced by areas with refuge to the potential offender, and low prospect and poor escape for possible victims. Fisher and Nasar (1992) suggested that reducing the height or increasing the permeability of visual barriers (i.e. shrubs and walls) and eliminating or opening up alcoves and blind corners can be judged to be relatively safer. They also advocated designs that provide long lines of sight, wide angles of view and enhanced lighting on the street, as well as mentioning how escape points can improve visibility and aid natural surveillance for legitimate users. In conclusion, prospect-refuge theory can be used to evaluate “hot spots” and “cold spots” according to the setting of environmental features. Darkness and sealed areas can increase people's fear in an open space, while covert substances and stumbling blocks can increase risks to passers-by. Even in a safe place, fear of being a victim can be increased by physical features.

3.2.5 Space Syntax Theory

Space syntax is a specific mathematical methodology developed by Hillier and Hanson with their team of researchers at University College London, England, that utilizes analytical techniques and attaches quantitative values to the relationships of spaces from the micro to the macro scale for urban environmental design. Rooted in graph theory and the idea of urban morphology, space syntax theory describes and measures quantitatively the configurational
properties of urban space (Hillier & Hanson, 1984). These techniques explain the relation between spatial environments and users’ behaviors from a sociological point of view. Hillier (1988) argues that if the spatial configuration makes the natural movement of pedestrians more difficult, there will not be a sufficient number of people to generate the perception of a well appropriated and used space. In other words, the more intelligible the space is, the less dangerous it seems. Intelligibility is defined as “the degree to which what we can see from the spaces that make up the system - that is how many other spaces are connected to- is a good guide to what we cannot see, that is the integration of each space into the system as a whole” (Hillier, 1988).

Through computer modeling of housing estates, Hillier showed that there is a direct relationship between the lack of outward-facing dwellings and fear amongst pedestrian movement, as well as an actual pattern of crime and antisocial behavior. Hillier and Shu (2000, p. 226) claimed that “linear integrated spaces with some through movement and strong intervisibility of good numbers of entrances . . . are the safest spaces”. Empirical research supports this idea by showing that places with higher accessibility tend to have lower crime rates, while places with low accessibility, i.e. segregated places, have higher crime rates (Shu & Huang, 2003). Their analyses also suggested that the risk of burglary was over two times higher on cul-de-sacs than on more permeable through-roads (Shu & Huang, 2003), although cul-de-sacs are thought to be safe if they are linear and part of a larger system of linear roads (Johnson & Bowers, 2009). One of the main conclusions is that connected and linear streets can enhance sight lines and attract higher pedestrian movements, thus increasing natural policing and more “eyes on the street”.

3.2.6 Comparison

Based on ecological theories of crime prevention, certain places within the environment exhibit
characteristics that would increase or decrease vulnerability of crime. Various features of the physical environment are considered to enhance territoriality and surveillance, thereby influencing the capability of inhabitants to detect crime. Some possible factors of the physical environment would affect natural surveillance (e.g. vegetation, lighting and the placement of windows), some might influence accessibility (e.g. the placement of buildings and exits) and some could affect the sense of territory (e.g. fences, signs and distinctive pavement). Many researchers have individually discussed how physical variables influence crime rate, and have investigated how proposed modifications might improve the safety of city neighborhoods. In the following passages, a number of physical factors in each environmental crime design theory, which include “Eyes on the Street”, Defensible Space Theory, Prospect-Refuge Theory, Crime Prevention through Environmental Design and Space Syntax Theory, are compared and analyzed in a correlation matrix (Table 1, see below), which shows that several tactics of environmental design theories on crime control may contribute to a safe exterior environment.

Table 1: Matrix of Environmental Features and Crime

<table>
<thead>
<tr>
<th>Theories</th>
<th>“Eyes on the Street”</th>
<th>Defensible Space</th>
<th>CPTED</th>
<th>Prospect-Refuge Theory</th>
<th>Space Syntax Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streets and Pedestrian Paths</td>
<td>The pathway should provide a clear</td>
<td>Widening of the path, using colored and decoratively scored paving</td>
<td>In a commercial environment, on-street parking, wide</td>
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<td>boundary between public space and private space (Jacobs, 1961, p. 35).</td>
<td>sidewalks, two-way streets and non-synchronous traffic signals can decrease vehicle capacity (Crowe, 2000, p. 130). In a residential environment, each end of the block could be choked off. Crosswalks should be legally designated under local ordinances to</td>
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Create pedestrian right-of-way and should be raised two to three inches to reinforce drivers’ perception of transition (Crowe, 2000, p. 178).

<p>| Buildings | Orient buildings to encourage surveillance by residents (Jacobs, 1961, p. 42). | Buildings should be oriented in such a manner that residents can easily see the outside street. Lobby areas should be designed so that activities | Face buildings toward court yards with entrances in line of sight of all buildings; keep number of buildings sharing a | The buildings should be “constituted outward facing block” (Hillier, 1988). |
| occurring inside the building may easily be seen from the street. Repaint a building to reduce its stigmatizing appearance. Fire escapes, windows, floor plans and roof landings could be altered to enhance the ability of residents to monitor the activities of friends and strangers (Newman, | common courtyard to a minimum (Crowe, 2000, p. 259). |</p>
<table>
<thead>
<tr>
<th>Entrances and Exits</th>
<th>Limit entrances (Newman, 1972, p. 71).</th>
<th>Limiting the number of entrances or exits to only legitimate users may enhance natural access in buildings (Crowe, 2000, p. 256).</th>
<th>Multiple exit points close at hand offer easy escape for legitimate users (Nasar &amp; Jones, 1992).</th>
<th>Ensure that accesses to dwellings have several lines of sight that connect to one particular sightline; Minimize secondary access to dwellings. (Stonor &amp; Hillier, 2008).</th>
</tr>
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<tbody>
<tr>
<td>Windows</td>
<td>The provision of windows also allows for excellent Place windows in overlooking isolated area</td>
<td>Place windows in overlooking isolated area</td>
<td>Place windows in overlooking isolated area</td>
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<tr>
<td>Walls</td>
<td>Differentiate front lawns</td>
<td>Retaining walls with Reduced height of the</td>
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<tr>
<td><strong>Fencing</strong></td>
<td>A fence is the symbol of territory (Newman, 1972, p. 56).</td>
<td>Fences and barriers provide a clear border definition of controlled space (Crowe, 2000, p. 58 &amp; p. 127).</td>
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<tr>
<td><strong>Door and Key Control</strong></td>
<td>Locked gates and doors (Newman, 1972, p. 63).</td>
<td>Provide businesses with security devices to detect and</td>
<td></td>
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<tr>
<td>Signs</td>
<td>Signs can raise awareness of security (Crowe, 2000, p. 58).</td>
<td>Better signs can reduce fear of crime (Nasar &amp; Jones, 1997).</td>
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<tr>
<td>Emergency Vehicles</td>
<td>Install fire alarms on emergency doors (Newman, 1972, p. 70).</td>
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<tr>
<td>Amenities</td>
<td>Location on the grounds of amenities such as play and sitting areas, washer-dryer facilities and Placing amenities such as seating or refreshments in common areas in a</td>
<td>Adequate seating and street furniture (Stonor &amp; Hillier, 2008).</td>
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automobile repair facilities will tend to give an area a high intensive use and strong sense of territory (Newman, 1972, p. 70). The addition of public seating in the center of the public path, located at a distance from private dwellings may be sufficient to eliminate conflicts over use (Newman, 1972, p. 169).

commercial or institutional setting helps to attract larger numbers of desired users (Crowe, 2000, p. 130).
After the comparison in Table 1, all of these five theories demonstrate a similar understanding of how physical elements can influence the incidence of crime. It is clear that lighting is the most important element in criminal prevention. All five theories admit that increasing lighting can help to prevent crimes. Proper lighting might increase the perception of natural surveillance to make normal users feel safe and to make abnormal users be alert to greater risks for their intended activity. Thus, providing effective use of lighting in all paths, sidewalks, parking lots and any isolated areas can minimize crime occurrences.

Vegetation and building design are other important physical elements for criminal prevention. The influences of vegetation are mentioned in all of the previously mentioned theories except Jacob’s “eyes on the street”. The authors argue that tree and shrub plantings have a close relationship with crime. Plantings can be used to improve spatial definition, surveillance, access control and way-finding (Crowe, 2000). But, they should be carefully planned. High vegetation along the public footpaths can produce opportunities for criminals to hide and then attack passers-by. Shrubs should be short enough to increase visibility and trees should be tall enough to avoid hiding places. “Eyes on the street”, defensible space theory, CPTED and Space Syntax theory all mention architectural design. The site design and the orientation of the building groups may directly affect opportunities for natural surveillance and accessibility. Buildings should be located with windows overlooking potential problem areas such as parking lots, building entrances and exits, children’s play areas, congregation areas, etc. Also, defensible space theory, CPTED and Space Syntax theory state that limiting entrances and exits of the buildings can enhance territorial identity and access control. Controlling building access through space management strategies will reduce ingress to one entry during vulnerable times and promote the
efficiency of security observations. Nasar and Jones (1992) believed that adding high escape points could offer easy escape for legitimate users. In addition, they advocated avoidance of isolating an individual entrance at the end of a hall or the head of stairs to provide natural surveillance and access control.

Compared to vegetation and building design, only three theories mention the positioning of streets and pedestrian paths; the use of walls and outdoor amenities can be crime prevention measurements which are less significant. Defensible space provides a similar understanding of pathway design as does “eyes on the street”. Both of them suggested that the pathway should provide a clear boundary between public and private space to increase the sense of territory. Newman also gave a more detailed explanation, explaining that wide paths should be used in different colors and decorations to distinctively identify public and private space. CPTED suggested that streets and pathways should be designed differently in commercial and residential environments. According to Defensible space theory, CPTED and Prospect-refuge theory, the presence of high walls is associated with hiding spots and possible assaults. Short walls or retaining walls with stretched cable railings can allow for maximum surveillance and illumination. Thinking of outdoor amenities, Newman argued that seating enhance natural surveillance and territory of outdoor space such as playgrounds and sitting areas. CPTED and Space Syntax theory both believe that good amenities located near activities ensure visibility and encourage high level use within public spaces.

There are other physical elements that have been referred to in the context one or two of the previously mentioned theories, such as windows, doors and locks, fences and barriers, signs, public video surveillance, and emergency vehicles. Windows and doors ensure maximum visibility and surveillance. Appropriate signs and fences show clear demarcation between public
and private spaces in order to achieve good levels of security and to reduce hiding places for criminals.

To sum up, it is evident that none of the five theories discussed above provides a complete understanding of the physical elements that can influence the incidence of crime. Although these five theories seem to be highly aware of the importance of street lighting and vegetation, they do not provide any standard requirements. How to define a well-lit environment or the proper height of vegetation is uncertain. In addition, even though other physical elements such as walls, amenities, fences, signs, public video surveillance and emergency vehicles are less noted in these theories, they may have a useful value in targeting the strengthening and perception of safety. Therefore, it is necessary to investigate further case studies to discover the relationship between environmental factors and crime.

3.3 Case Studies about Environmental Factors and Crime

Compiling from the above mentioned sources a large number of crime prevention ideas, the following case studies continuously supplement and deepen the research into the relationship of physical design elements and crime. The case studies review the empirical and theoretical literature on the physical elements for crime reduction, as well as suggesting future strategies for crime prevention.

3.3.1 Lighting

Lighting design has the capacity to promote informal or natural surveillance opportunities for residents. Carefully positioned lighting can also help create a feeling of ownership of spaces for the surrounding houses (Colquhoun, 2004). A number of case studies evaluate the relationship of
lighting and crime. Herbert and Davison (1994) evaluated street lighting in Cardiff and Hull, six weeks after installation of the improved lighting (from original low-pressure sodium (yellow) to high pressure (white) sodium light. There were clear indicators that improved street lighting led to higher levels of community safety amongst residents of the two study areas and a slightly greater number of pedestrian usage, particularly after 21:00 hours. Another study by Painter (1996) investigated street light improvements at sites in Edmonton, North London, Tower Hamlets and Hammersmith and Fulham. All sites were urban streets, badly lit (the low pressure sodium lights did not meet the minimum British Standard BS5489, Part 3, category 3/3) running through mixed use locations. A survey was conducted after street lighting improved; it showed that between 17:00 and 23:30, incidents of crime were markedly reduced in all areas. There was also a marked reduction in the fear of attack and a corresponding increase in perceived personal safety. There was also a significant increase in pedestrian usage of the street after the street light improvements.

Schreuder (1998) presented a study to show that a reduction in accidents involving injuries of 30% can be expected at night following the improvement in lighting from very bad to good. In recent years, Farrington and Welsh (2002) re-examined a number of studies of lighting and crime research in the UK and the USA. Thirteen improved lighting programs were included the evaluation criteria, but sixteen were excluded because of several poorly designed lighting evaluations. The results showed that overall improved lighting led to a significant 20% decrease in experimental areas compared with control areas. The meta-analysis found that improved street lighting reduced recorded crime by 7% in the eight American studies and there was a 30% decrease in the five UK studies. Furthermore, in two of the UK studies the financial savings from reduced crime greatly exceeded the financial costs of the improved street lighting. Farrington and
Welsh’s study suggested that improved lighting should be an effective tactic for the crime reduction program. However, since the study did not find that night-time crime decreased more than day-time crime, it was likely to have an effect by increasing community pride and informal social control rather than by simply improving surveillance opportunities (Farrington & Welsh, 2002).

The study also showed that improved lighting may be more effective in reducing crime than CCTV; in city centers and public housing settings CCTV led to a negligible reduction in crime of about 2% in experimental areas compared to control areas. Farrington & Welsh (2002) found that CCTV had no effect on violent crimes, but significantly reduced vehicle crimes by around 41% in car parks in experiments compared with control areas, although other measures were also operating in the car parks. In 2003, Willis focused on the value of improved street lighting in urban and rural areas. He conducted a survey of about 1000 people in the Bedfordshire, North Yorkshire and Wiltshire areas. The result showed that around 70% of respondents thought that improved street lighting would reduce crime; improved street lighting would make private property more secure; and 80% said that street lighting made them feel safer from crime after dark. Thus, improved street lighting was perceived as a practical mechanism that could enhance the environment and personal safety and reduce crimes, thus helping people feel safe to go out after dark. According to these studies, it was evident that street lighting could have an effect in reducing crime, improving night-time environment, increasing traffic safety and encouraging economic activities at night.

There are a number of good lighting schemes that have been applied in various design guidelines, although none of them have been well evaluated. For example, Newman (1996) argued that “the intensity of lighting shall be 0.5 foot candles minimum for parking lots and
walkways; and 4.0 foot candles for townhouse entrances, ramps, and steps. Parking lighting poles shall have a minimum height of 25’0” and pedestrian walk lighting poles a height of 12’ to 15’.” Colquhoun (2004) argued that lighting in public spaces must be adequate for people to have a good look at another person when he or she is still a reasonable distance away, which is usually no more than 12 to 15 meters. The guideline of CPTED in Virginia suggested that designers should provide enough light so that people can identify others’ faces from 50 feet away, and recommends using the same kind and the same color of lamps throughout the site because different color or different luminance of light will reduce visibility. In multi-family residential areas, parking lot lighting should be at a minimum-maintained level of 1.0 foot-candles or 10 lux (Virginia CPTED Committee and the Virginia Crime Prevention Association, 2005).

In brief, lighting should be an effective tactic for crime prevention. Lighting can support visibility for pedestrians and possible entrapment spaces in order to enhance natural surveillance. However, in order to understand the effectiveness of lighting, a detailed requirement of lighting in CPTED needs to be tested in future studies.

3.3.2 Vegetation

It has been a tradition to remove vegetation for safety in problem areas (Kuo & Sullivan, 2001). A number of park authorities, universities, and municipalities across North America are engaging in active programs to remove vegetation because it is thought to conceal and facilitate criminal acts (Nasar & Fisher, 1993). However, some researchers believe that vegetation can increase surveillance and mitigate some of the psychological thinking that might lead to violence. It can also be used advantageously to prevent access into private and semi-private areas. Defensive plantings are about selecting the right type of plant material for each situation (Colquhoun, 2004).
For instance, open-branched and columnar trees are best where surveillance is important. Climbing trees are useful to cover walls that are subject to graffiti, and thorny plants can help keep people way in vulnerable areas.

Stamen (1993) surveyed landscaped and non-landscaped areas in a community and found that the incidence of vandalism or graffiti in sites without plantings was 90% as compared to 10% in sites with plantings. Similarly, Brunson (1999) examined both physical and social incivilities in public housing outdoor spaces with trees and grass versus in similar spaces without vegetation. Resident reports indicated that graffiti, vandalism, and littering were systematically lower in outdoor spaces with trees and grass than in comparable, more barren spaces (Brunson, 1999). Furthermore, resident reports indicated that social incivilities, such as the presence of noise, disruptive individuals, strangers, and illegal activity, were also systematically lower in the greener outdoor spaces (Brunson, 1999).

Kuo and Sullivan (2001) published a study that found that public apartment buildings surrounded by trees and greenery are dramatically safer than the buildings devoid of green. By using police crime reports, 98 apartment buildings in the inner-city neighborhood were examined to explain the relationship between vegetation and crime rate. Buildings with medium levels of vegetation had 42% fewer total crimes than those with low levels of vegetation, including 40% fewer property crimes and 44% fewer violent crimes. Buildings with high levels of vegetation had 52% fewer total crimes than lower levels, including 48% fewer property crimes and 56% fewer violent crimes. These results indicate that the greener a building’s surroundings, the fewer total crimes (property crimes and violent crimes) occur. Also, the findings proved that vegetation would not promote crime when it preserves enough visibility. When buildings are widely spaced with high-canopy trees and grassy areas, crime should not be promoted. Vegetation can
encourage people to participate in outdoor activities, lowering levels of aggression as well as levels of incivilities. The greener outdoor spaces may receive greater use, thus increasing informal surveillance and thereby discouraging criminals.

A few design principles provide the standard height of the trees and plantings which make the environment safer. CPTED states that it is desirable to “keep shrubs trimmed to a maximum of 3 feet, or at least below windowsills, when safety is an issue. Tree canopies should have a natural growth height of at least 4 feet from the ground when located around entrances, parking areas, and walkways (Virginia CPTED Committee and the Virginia Crime Prevention Association, 2005).” Secured by Design (SBD), a UK Police initiative to support the principles of designing to prevent crime, suggests that as a general rule shrubs should have a mature growth height of no higher than 1m (3ft) and trees should have no foliage below 2m (6ft), thereby allowing a 1m clear field of vision (Colquhoun, 2004). Although CPTED and SBD offer slightly different guidelines for the height of plantings, they both agree that a well-maintained landscape can prevent blind spots and hiding spaces, because these areas are where crimes can occur. A spatial analysis of residential burglaries in Tallahassee, Florida found that duplexes with trees limbs that are less than 6 feet off the ground are five times more likely to be burglarized (Clontz, 1997). This study shows that overgrown or untrimmed plantings can increase incidence of crime.

In conclusion, vegetation can be another effective way to prevent crime. Strategic plantings can be used as barriers to deter access and to divide private and public places. Proper height of the landscaping reflects its effectiveness. Otherwise, too tall and too dense shrubs or too large trees can detract from pedestrians’ ability to see or be seen and may provide hiding places and secluded areas where crime could flourish. Thus, it is necessary to identify what the proper heights of street trees and shrubs should be. It is also important to evaluate the requirements of
vegetation according to CPTED and SBD.

3.3.3 Public Video Surveillance

More recently, public video surveillance has been regarded as a useful crime prevention tool for guardianship. Closed Circuit Television (CCTV) has been used extensively in the United Kingdom and the United States and has been found to reduce thefts within defined locations such as shops, buses, car parks, the London Underground and sports grounds (Wilson & Sutton, 2003). Using cameras can prevent crime occurrence and detain the offenders based on camera evidence.

Several evaluations indicate that CCTV deployment has had positive results in certain circumstances. Brown (1995) found that CCTV camera systems can help reduce the incidence of property crime within town centers. In Newcastle and King’s Lynn, and to a lesser extent Birmingham, property crime has been reduced in those areas covered by cameras. This refers mainly to the burglary of shops, but also to theft of and from vehicles. Short and Ditton’s (1996) evaluation found that introduction of CCTV had 21% fewer crimes, and offences were recorded in the 2 years after installation of CCTV in Airdrie town centre. Crimes of dishonesty declined by 48% over the same period, while crimes of vandalism and fire-raising fell by 19%.

Armitage et al (1999) reported that the area in Burnley covered by CCTV showed crime reductions of 25% in 1996 and 16% in 1997 relative to statistically expected levels. Welsh and Farrington’s (2002) meta-analysis compared 13 evaluations in city centers and in public housing of England, U.S. and Scotland. Five of the evaluations found a positive effect (decrease in offences) and three found an undesirable effect (increase in crime); the remaining four found no effect and in one case the evidence was unclear (Farrington & Welsh, 2002, p. 13). These studies attempted to link the effectiveness of CCTV to improve the overall crime rate, especially for
vehicle crimes in car parks and some other forms of acquisitive crime. However, some findings have been less positive. The statistical analysis of recorded overall crime in Glasgow increased 9% after CCTV was installed there. Offences of dishonesty, indecency and miscellaneous offences showed the most significant increases; however, serious violence, vandalism and vehicle offences decreased (Ditton et al, 1999).

Although the cost of CCTV is rather expensive, a CCTV system still could be one element of broader crime prevention strategies. The majority of research suggests that CCTV is successful in reducing crime and enhancing feelings of public safety, but a few studies present the opposite opinion. Thus, further study is needed to re-examine its practicality.

3.3.4 Building Design

Buildings with fewer apartments per entryway, fewer stories, and better views of the outside have residents with lower levels of fear and rates of victimization (Newman & Franck, 1982). CPTED also suggests that front entrances which are clearly visible from the street and windows of principal rooms that are positioned to maximize casual overlooking of public spaces could deter crime. The Secured by Design (SBD) strategy involves limiting traffic access by building developments on cul-de-sacs, creating greater oversight around a single road entry into neighborhoods, maximizing the opportunity for natural surveillance through strategic window and door placement, orienting dwellings to maximize oversight of areas, limiting access to dwellings through site layout, and outfitting houses with good locks and building products (Weisel, 2002). Studies in West Yorkshire, UK showed that burglary offences were reduced by over 50% and the overall perception of the residents of crime and disorder were reduced after applying the schemes of Secured by Design (Colquhoun, 2004).
Besides, houses with good locks, burglar bars or other security devices can help to avoid the occurrence of burglars (Weisel, 2002). In about two-thirds of reported U.S. burglaries (including commercial), the offenders forced entry, mostly through unsecured windows and doors (including sliding glass doors) (Weisel, 2002). In the UK (Budd, 1999, p. 60), reports intimated that 61% of recorded burglaries involved forced entry through doors and windows (3% were forced open, 24% were smashed), and 22% involved no forced entry, where locks and windows were left open. Thus, several target-hardening strategies such as upgrading locks, robust doors and windows at points of access, and the use of double-pane glass can reduce the risk of burglary and vandalism. Such security devices slow offenders down and make them more vulnerable to being found. A study by Allatt (1984) found that the usage of locks on windows and doors affected a gross increase of 30% in burglaries, but a net reduction of between 24-29% compared to control area and BCU wider area, respectively. In Chula Vista, California, the police department undertook a modified project which included installing dead bolts on garage service doors, windows with forced-entry resistance, and pin locks on sliding glass doors (Weisel, 2002). These measures resulted in a 50 percent decline in burglaries over two years in the reporting area (Weisel, 2002).

Therefore, it is clear that building design is important for crime prevention programs. Buildings with proper locks, robust doors and windows facing the street, and the use of double-pane glass can enhance security and natural surveillance; on the contrary, building that are badly maintained will attract offenders and increase the risk of crime.

3.3.5 Fencing

Fencing is used to restrict access to property and increase neighborhood safety. It includes
fences, gates and turnstiles. Defensible space theory and CPTED both believe that the use of sight-limiting fencing can deter crime. Colquhoun (2004) mentioned that “post and chain fencing is sufficient protection to front gardens of these houses at Welwyn Garden City (p. 105)”. Lockable gates help to keep down the number of burglaries because they are not easy to climb over. It has been proved that a gate can decrease rear access burglaries by up to 90% (Colquhoun, 2004). Beckford and Coogan (2000, p. 11) specified that the design of the gates should be strong and solid, with a clear line of sight down the communal alley way, and that metal is better than timber, and should be fitted with an automatic deadlocking mortice lock. In the mid-1990s, a pilot project of gating alleys was developed in the city of Haalerm in the Netherlands. The scheme included securing the paths with gates and installing lighting. A survey of 572 houses showed that 39% of residents raised their safety perception after the measures that were taken. There was a 57% decrease of burglary crimes after the project. Therefore, the risk of burglaries decreased significantly and the awareness of safety rose considerably (Colquhoun, 2004). Ekblom (2002) reported on an alley-gating project in Birmingham, England where 80% of burglaries were committed using access from rear alleys. After erecting 62 alley-gates and steel palisade fencing, the distribution of 400 ultraviolet property-marking kits and stickers and a local newsletter, a 53% decline in burglaries was reported (Cozens et al, 2005).

In a word, fencing can be used to define public space and private space, as well as to create a sense of ownership. Although not many researchers have studied the effectiveness of fences, this paper will continue to explore the connection between fencing and crime.

3.3.6 Signs
Signs are relatively inexpensive to produce, and they are easily posted in relevant areas. There are many kinds of signs installed in neighborhoods and traffic areas, such as stop signs, speed limit signs, neighborhood watch signs, yard signs, street name signs, school pedestrian crossing signs, etc. Some of these signs may have an impact on crime prevention, but rarely have case studies tended to evaluate those signs. In England, signs on buses significantly reduced bus vandalism that warned youths that they were being watched via CCTV, and that infractions would be reported to the police (Poyner, 1988). Neighborhood Watch signs are designed to warn offenders. Three studies in California were conducted to examine the causal impact of Neighborhood Watch sign presence and content on perceived crime rates, likelihood of victimization, community safety, and estimates of home and community quality (Schultz & Tabanico, 2009). The results of laboratory data show that Neighborhood Watch signs can result in an increase in fear of crime and worry about victimization. However, this analysis did not support Crowe’s CPTED that “signs can raise people's awareness of security (Crowe, 2000, p. 58)”. In the further study, this paper will test its usefulness compared with these two results.

3.4 Summary

Design physical elements within the built environment have an inseparably close relationship with crime. In a review of studies, properties with low levels of lighting at night, high walls/fences, or thick trees or shrubbery can provide concealment opportunities for burglars, particularly when close to points of access such as windows and doors (Weisel, 2002). In the Netherlands, improved public lighting, improved door and window furniture, proper external lighting attached to houses, and a clear view of the street and parking places resulted in a drop in the burglary rate from 120,000 to 86,000 offences in 2000 (Colquhoun, 2004, p.217).
In summary, most of the case studies and five theories mainly focus on the effectiveness of physical elements, lighting, vegetation, CCTV, fencing and building design. The studies prove that these five elements can decrease property and violent crime remarkably. Besides, research studies have verified some tenets of the theories. They prove that properties with steady public lighting, low hedges or planters, wide use of CCTV, wrought-iron gates and chain link fences, and appropriate door and window design enhance the visibility of the surroundings and possibly also enhance safety. Conversely, low levels of lighting, tall and thick trees or shrubbery, high solid fences or barriers, improper placement of CCTV and building layouts which are attractive for offenders to hide and hard to be seen are not as effective. However, until now, no study has verified the reference standard of these elements which can lower the incidence of crime. For instance, CPTED suggests keeping shrubs trimmed to a maximum of 3 feet, but no study proves the practicality of this statement. Other physical elements such as signs, walls, emergency vehicles and seating have also not been well evaluated in any case studies.

In the following chapters, this paper will evaluate the tenets of five theories and the results of related research studies, so as to identify whether the environmental factors they describe are effective as part of a crime prevention strategy. In addition, those factors include landscaping considerations, such as shrubbery and tree height; housing design (e.g. entrance, door and window placement) and strength of doors, windows and locks; and the placement of CCTV, fencing and signs will be taken into consideration.
CHAPTER FOUR
METHODOLOGY

4.1 Introduction

The above review of the literature described that environmental design has certain effects on crime prevention. This chapter describes the research methodology used for investigating the relationship of different physical elements with the incidence of crime. The research was conducted in the Gonzaga University District, in Spokane, Washington. After the selection of this district was made, a test was applied to compare the hypothetical “hot spot” obtained from site observation and the actual crime data obtained from the Spokane Police Department. The main purpose of the case study was to evaluate the tenets of five theories and related research studies. Also, the test was intended to examine the physical values of design features for crime prevention.

4.2 Hypothesis

There is a positive correlation between physical factors and actual crime location. Based on the conclusions of the five environmental crime prevention theories and further case studies, the general hypothesis is that crime patterns are not uniformly distributed, depending instead on relevant environmental factors. From this aspect, 11 specific research hypotheses were developed.

H1: If a place lacks sufficient street lighting such that people cannot identify faces from 50 feet away, the risk of crime increases.

H2: If shrubbery is above 3 feet high or reaches above windowsills, the risk of crime increases.

H3: If trees have foliage less than 6 feet off the ground, the risk of crime increases.

H4: If CCTV is installed on the street or around the building, the risk of crime decreases.
H5: If structures face toward the street, the risk of crime decreases.

H6: Buildings without limited entrances have a higher risk of crime.

H7: Buildings without deadbolt locks have a higher risk of crime.

H8: Buildings without burglar bars on the windows have a higher risk of crime.

H9: Buildings without flood lights have a higher risk of crime.

H10: Properties without fences have a higher risk of crime.

H11: If signs are in place, the risk of crime decreases.

4.3 Study Area Selection Criteria

In order to test this hypothesis, this pilot study aimed to provide suitable data for analysis and comparison. The Gonzaga University District in Spokane was selected for this research as the field study area because it best met the established criteria.

The important criteria that were considered are as follows:

1. The mixed land use in and around the campus district has the required eleven environmental factors.

The Gonzaga University District is located in the Logan neighborhood that is generally bounded by the Spokane River and the Centennial Trail on the south, Hamilton St. on the east, Sinto Ave. on the north, and Ruby St. to the I-90 freeway on the west. The north and west sides of the Gonzaga campus are mostly comprised of student and residential housings. The eastern side is mainly comprised of restaurants, bars and retail stores. The north side includes the Washington State University-Spokane and Eastern Washington University’s Riverpoint Campus, half a mile from downtown Spokane. Besides, a few studies have directly measured mixed-land
use and reported that it is associated with higher crime rates (Sampson, Morenoff, & Gannon-
Rowley, 2002). Thus, this mixed use area which is surrounded by heavily student-populated
neighborhoods and business services could be crowded with crime. Furthermore, the site
contains most of the required environmental features for measurement, including street lighting,
vegetation, CCTV, buildings and housing, lockable doors, windows, fences, signs, etc.

2. Availability of data.

Data for this study were obtained from two sources. First, crime data for this study were
gathered from the Spokane Police Department. This detailed information of the area dates from
February 1, 2005 until April 30, 2010. The study focused on crimes of assault, burglary, theft,
and robbery. The second source of information was gathered from the evaluation of on-site
observations.

3. Applicability of findings to other American cities.

From the point of view that physical elements can prevent crime, the Gonzaga University
District contains a range of land use and environmental patterns that are common to many
American cities and neighborhoods which have similar socio-economic factors.

4.4 Research Methodology

In order to explore the actual impact of the environmental characteristics on crime, this research
carried out a modest field experiment to evaluate eleven hypotheses in the Gonzaga University
District. I observed the existence and conditions of these environmental elements. Then,
considering the theories and case studies about the asserted effect of these elements, I evaluated
each of the physical factors and speculated as to the locations of “hot spots” in and around the
district. After that, I analyzed actual crime data. Finally, using correlation coefficient statistics,
the research analyzes the relationships between environmental factors and crime and whether the study results support the tenets of the five environmental crime prevention theories.
5.1 Data Analysis Procedures

The present case study explores the relationship between crimes and environmental factors using qualitative research methods. The data analysis procedures include three steps: observational analysis; actual crime data analysis; and analysis of the correlation between the observation and crimes. This study mainly focuses on four crimes: assault, burglary, theft and robbery. The definitions of these crimes are given by the Uniform Crime Reporting (UCR). Accordingly, this research uses the definition of assault, which is “an unlawful attack by one person upon another for the purpose of inflicting severe or aggravated bodily injury.” The definition of burglary is “the unlawful entry of a structure to commit a felony or a theft.” Robbery is defined as “the taking or attempting to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in fear.” Finally, the definition of larceny-theft is “the unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another.”

5.2 Rating Scheme of Site Observation

In order to facilitate observation, the district was divided into 31 zones by blocks (see Figure 2). Some zones are composed of one block along the center line of roads (e.g. Zones 1-17, Zones 20-23), some zones are composed of two blocks (e.g. Zones 18, 19, 29 & 31), and the other zones are composed of irregular shore line...
(e.g. Zones 24, 25, 26, 27, 28 & 30).

As discussed earlier, prior theories and studies have explored the relationship between crime and lighting, vegetation, CCTV, the orientation of a building, lockable doors and windows, and signs. CPTED in Virginia suggested that designers should place enough light so that people can identify others’ faces from 50 feet away, and keep shrubs trimmed to a maximum of 3 feet, or at least below windowsills. Secured by Design (SBD) suggested that shrubs should have a mature growth height no higher than 1m (3ft) and trees should have no foliage below 2m (6ft), thereby allowing a 1m clear field of vision (Colquhoun, 2004). As noted above, no recent research has evaluated whether these recommendations work or not. The following case study intends to evaluate these recommendations. Some studies have shown that CCTV, building design and signs can affect the incidence of crime, so the present work also intends to examine these categories in order to compare results with previous studies (see 3.3.3-3.3.6).

According to the five theories and prior research about the effects of these elements, the rating schemes of environmental factors (shown in Table 2) provide a reference for evaluation. The names of environmental factors and their descriptions are also listed in Table 2.

Table 2: Rating Scheme of Environmental Factors

<table>
<thead>
<tr>
<th>Hypothesis Number</th>
<th>Name</th>
<th>Description</th>
<th>Rating Scheme</th>
</tr>
</thead>
</table>
| 1                 | Street lighting (SL) | Street lighting allows people to identify others’ faces within 50 feet. | 2 = No Lighting  
|                   |                   |                                                       | 1 = >50ft.            |
|                   |                   |                                                       | 0 = < 50 ft.          |
| 2                 | Shrubbery (SH)    | Shrubbery is below 3 feet on the walkway or at least below the window sill in front of the building. | 1=No  
|                   |                   |                                                       | 0=Yes                |
An on-site survey was conducted to show the condition of each of the factors identified in this study. The rating score measures the degree to which the environmental features would meet the requirement of the descriptions listed in Table 2. On one hand, every index of each factor in one zone represents its average condition of four sides of the zone. Each factor was examined

<p>| | | | |</p>
<table>
<thead>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Trees (TR)</td>
<td>Tree limbs are at least 6 feet from the ground.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>4</td>
<td>CCTV (CV)</td>
<td>CCTV is on the street or around the house.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>5</td>
<td>Buildings (BU)</td>
<td>Building is facing toward and visible from the street.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>6</td>
<td>Entrance (EN)</td>
<td>Limited building entrance.</td>
<td>1=&lt;3 0=&gt;3</td>
</tr>
<tr>
<td>7</td>
<td>Lock (LO)</td>
<td>Deadbolt lock on the door.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>8</td>
<td>Window bars (WB)</td>
<td>Burglar bars on the window.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>9</td>
<td>Flood lighting (FL)</td>
<td>Flood lights on the building.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>10</td>
<td>Fences (FE)</td>
<td>The property has a fence.</td>
<td>1=No 0=Yes</td>
</tr>
<tr>
<td>11</td>
<td>Signs (SI)</td>
<td>Sign is present.</td>
<td>1=No 0=Yes</td>
</tr>
</tbody>
</table>
individually and recorded on the form (see Table 3). One the other hand, because not every property on the street has the same condition, this study measures the condition of each environmental factor that has more than 70% similar characteristics as the standard. For instance, if 80% of the houses face toward the street, the rating of building (BU) is considered as 0. The rating score for each factor ranges from 0-1. Each total score ranges from 0-11; the higher the sum, the more the likelihood of crimes.

5.3 Site Observation

I conducted the site observation along the streets during morning and late afternoon on three weekdays. I took photos and rated every element on each side of the zones based on the rating scheme. Then, I averaged the total scores of four sides of the zones for each element. Table 3 shows the final results of the site survey.

Table 3: On-site Survey

<table>
<thead>
<tr>
<th>Factor Zone</th>
<th>SL</th>
<th>SH</th>
<th>TR</th>
<th>CV</th>
<th>BU</th>
<th>EN</th>
<th>LO</th>
<th>WB</th>
<th>FL</th>
<th>FE</th>
<th>SI</th>
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<tr>
<td>1</td>
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</tr>
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5.3.1 Site Factors Analysis

Table 3 shows differences among the features in each zone. The data mapping and statistical analysis were conducted using a geographic information system (GIS). Different colors of the zones in Figure 3-14 show different ratings of probable crime. The darker color means the zone has higher probable crime, while the lighter color means the zone has less probable crime. After analyzing the site observation and data mapping, I discuss each factor below.

**Comprehensive Factors (TOTAL):** The mean of TOTAL is 3.96 and the standard deviation is 1.09. The standard deviation shows that the distributions of comprehensive factors are uneven. As Figure 3 shows, Zone 8 (the darkest-colored zone) has the highest score, while Zone 30 (the lightest-colored zone) has the lowest score. Zone 8 has poor lighting, tall and thick shrubbery, improper building design, weak locks, and lack of CCTV, window bars, fencing and signs may increase higher possible of crime. Conversely, Zone 30 with steady public lighting, low shrubs, tall tree limbs, good lockable doors and appropriate fence design enhances the visibility of the surroundings and possibly safety. The other zones, with the exception of Zone 8 and Zone 30, have different conditions for each factor. Some zones have good lighting, proper height of trees and shrubs, but lack CCTV, fencing or signs. Some zones have poor lighting, untrimmed
vegetation, or worn-out locks, but have CCTV, fences and signs around the sites. So, even though total scores are the same, the environmental factors of these zones still have differences.

**Street lighting (SL):** The mean is 0.25 and the standard deviation is 0.32. The mean is low, which means most of the zones have enough illumination. The standard deviation is higher than for other factors. The higher standard deviation implies that the set of numbers are widely apart. Figure 4 shows Zones 2-4 are the highest probable crime zones (darkest-colored). Almost 30% of the zones do not have street lights located in the residential area, mainly on Sinto Ave and the north side of Sharp Ave. Especially at night, walkers cannot see anything unless there happens to be a car passing by. These dark areas increase feelings of insecurity and weaken nighttime surveillance. The lower probable crime zones (light brown and yellow zones) including Zones 9-15 & Zones 17-30, are mainly clustered in the middle and south of the study area. Good lighting encourages more students to walk in and near to the Gonzaga campus at night.

**Shrubbery (SH):** The mean is 0.27 and the standard deviation is 0.26. The mean is low, which means most that of the zones have low enough shrubbery. But the standard deviation is relatively high, which means the set of numbers is widely apart. Figure 5 shows that the highest probable crimes are located in Zones 8, 16, 22, and 29 (the darkest-colored zones), which are business and residential areas. Most shrubs along Hamilton Street are taller than 3 feet adjacent to pedestrian walkways, which provides hiding places for the potential criminals and blocks the view for the pedestrians to observe the surrounding environment. On the contrary, most of the shrubs are trimmed lower than the window sill of the school buildings and some apartments in the campus area (light brown and yellow zones). People indoors can easily see out and be aware of emergencies.
Trees (TR): The mean is 0.1 and the standard deviation is 0.17. The mean is low, which means most of the foliage is more than 6 feet off the ground. Trees are well maintained to avoid the possibility of hiding places. Figure 6 shows that Zones 23-27 (dark brown and brown zones) have a higher potential of crime than others. The existing large areas of grass and thick tall conifer trees along the Spokane River and Centennial Trail (in Zones 24, 25 and 27) are planted naturally without regular trimming, which could shield an attacker. Figure 6 also shows that the zones in and near the residential area (yellow zones) have lower probable crimes. Most of the trees in the residential area and between the parking lot and the road are used to define the pattern of main roads and footpaths. They are open-branched and less dense street trees that may provide clear and wide views for walkers.

CCTV (CV): The mean is 0.95 and the standard deviation is 0.10. The mean is very high, which means that only a few zones have CCTV. The standard deviation is low, which means the set of values are closely clustered near the mean. Figure 7 shows that most places have no CCTV (dark brown zones). Six CCTV cameras are installed on the university buildings in Zones 10, 18, 24, 25, 26 & 27 (yellow zones in Figure 7). They are monitored by security guards. CCTV surveillances look over the campus areas to help prevent burglary. Therefore, compared to other areas, the campus area has less possibility of crime.

Orientation of Building (BU): The mean is 0.04 and the standard deviation is 0.09. The mean and standard deviation is very low, which means that the set of rating scores are almost the same. Figure 8 shows that more than 90% of the front entrances and windows of principal rooms are facing the streets, except for several properties in Zones 7, 9, 16, 20 & 25 (dark brown zones) which face toward alleys or their backyards. Therefore, the buildings facing toward the street (in
yellow zones) provide maximize casual overlook of public spaces, which may increase natural
surveillance of the street and reduce violent crime and property crime rates.

**Entrances of Building (EN):** The only factor excluded from the analysis is EN. Because the
numbers of entrance are all less than three, hypothesis 6 is not testable.

**Deadbolt Lock (LO):** The mean is 0.13 and the standard deviation is 0.21. The mean and
standard deviation is relatively low. The distribution of deadbolt locks is relatively even. Most of
the structures have good deadbolt locks. Figure 10 shows that Zones 5-8, 10 &11 (dark brown
and brown zones) have higher probable crimes while other zones (yellow zones) have less
probable crimes. The locks of the front doors on the houses in some residential area appear old
and not strong, which seem easy to break. But some school apartments and buildings have
installed electrical password doors and some have installed automatic deadlocking locks which
can deter unauthorized access. Burglars prefer to break into a house without solid locks, so in
this case, Zones 5,7,8,10 &11 have more potential to be burglarized.

**Window Bars (WB):** The mean is 0.61 and the standard deviation is 0.30. The mean indicates
that few of the structures have window bars. The standard deviation shows the rating scores to be
widely apart. Figure 11 shows that most of the zones (dark-colored zones) have higher probable
crimes except Zones 22, 26 & 28 (yellow zones). In general, only a few buildings have window
bars in the 31 zones. Most of the buildings on the business strip on Hamilton Street have
installed window bars and solid locks. These precautions can discourage burglaries or at least
delay the time to commit crime. On the contrary, the university buildings show few window bars.
Perhaps the usage of CCTV in campus area can reduce the risk of burglary, and thus the campus
has not considered installation of window bars. The houses in the residential area are more likely
to be burglarized because they lack window bars and robust window frames.
**FloodLights (FL):** The mean is 0.48 and the standard deviation is 0.31, which means the distribution of flood lighting is uneven and most of the zones had probable crimes. Figure 12 shows that only Zones 19, 22, 26 & 30 (yellow zones) have few probable crimes. Most of the houses and buildings have not installed flood lights. The possible reason that flood lights are not installed in the campus area is because the street lighting on each side of the road is bright enough to provide direction. Only a few houses in Zones 1-16 have flood lighting. Although flood lighting can help create a feeling of ownership of spaces surrounding the houses, the illumination is still not adequate for people to have a safe feeling when walking on the sidewalk.

**Fences (FE):** The mean is 0.76 and the standard deviation is 0.21, which indicates that the distribution of fencing is uneven in the study area. Figure 13 shows that most of the zones have probable crimes except Zone 10 (yellow zone). Some houses on the west side of the residential area have wooden fences or wrought-iron fences in their front and back gardens. The east side of the residential, business and campus areas contains low fences in front of the buildings. Fencing can help define private, semi-private and public spaces, and can also increase the sense of territory for the residents. Thus, the places with fencing may deter criminal activity and reduce the fear of crime.

**Signs (SI):** The mean is 0.37 and the standard deviation is 0.29, which indicates that the distribution of signs is relatively uneven. Figure 14 shows that some of the zones have a high level of probable crimes, but some do not. Some kinds of signs have been installed in neighborhoods and traffic areas, such as stop signs, speed limit signs, yard signs, street name signs, house name signs, and school pedestrian crossing signs, etc. Eighty percent of the zones have clear signs to reinforce the message to drivers and walkers that those are different kinds of streets. During my observation, most drivers obeyed the traffic rules. Traffic signs may reduce
the number of traffic crimes. Street name signs and house name signs may increase the sense of territory for residents.

Figure 3: Probable crime map based on the evaluation of all factors.  
Figure 4: Probable crime map based on the evaluation of street lighting.  
Figure 5: Probable crime map based on the evaluation of shrubbery.  
Figure 6: Probable crime map based on the evaluation of trees.
Figure 7: Probable crime map based on the evaluation of CCTV.

Figure 8: Probable crime map based on the evaluation of buildings.

Figure 9: Probable crime map based on the evaluation of building entrance.

Figure 10: Probable crime map based on evaluation of doors.

Figure 11: Probable crime map based on the evaluation of window bars.

Figure 12: Probable crime map based on evaluation of flood lights.

Figure 13: Probable crime map based on the evaluation of fences.

Figure 14: Probable crime map based on the evaluation of signs.
5.4 Crime Data in the Study Area

The crime data was collected from the Spokane Police Department, which included the numbers of crime, crime locations and crime dates. The data was extracted from the entire Spokane city crime database. The crime areas included the inside and overlaid the boundary of the zones. Within the time frame from February 1, 2005 until April 30, 2010, 110 cases of assault, 49 cases of burglary, 13 cases of robbery and 473 cases of theft were reported. Table 4 shows the numbers of different crimes in 10 zones.

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Source: Spokane Police Department. (2010).
5.4.1 Crime Data Analysis

Different types of crimes have different distributions in the study area. I discuss each crime below. Different colors of the zones in Figures 15-18 show different distributions of level of crimes. The red zones indicate the highest crime rate, the orange zones mean the numbers of crime are relatively lower, next are yellow zones, after that are green zones, and the lowest are the zones with no color.

**Assault:** The average number of assaults is 3.55, which implies most of the zones have fewer crimes and only several zones have large numbers of assaults. The standard deviation for assault is higher than burglary and robbery, with a number of 6.01. The set of numbers are widely apart. Figure 15 shows that assaults were not uniformly distributed. Most assaults occurred frequently on Hamilton Street, especially in Zone 8 (the red zone), which has night bars and restaurants. A few assaults occurred occasionally in the residential area and campus area (the yellow and green zones). Assaults did not take place around the lake side area (Zone 27 with no color) where people seldom walked by.

**Burglary:** The mean is 1.58 and the standard deviation is 1.67. Compared to other types of crimes, the data indicates that burglaries occurred less and were relatively evenly distributed in all zones. The maximum numbers for burglary were in Zone 5 and Zone 31 (the red zones in Figure 16). Zone 5 is a residential area and Zone 31 is a commercial area. Some zones which are in or close to residential areas had few burglaries (the yellow and green zones in Figure 16). In the campus zones close to lake area (no color zones in Figure 16) burglary seldom took place because only a few university structures are there.

**Robbery:** There were very small numbers of robbery in the study area. The mean is 0.42 and the standard deviation is 0.85. The individual crime frequencies are similar, and the standard
deviation is the smallest compared to other types of crimes. In Figure 17, most zones were within no color, which mean few robberies occurred there. Zone 8 (the red zone) had more crimes than others.

**Theft:** The mean is 15.26 and the standard deviation is 26.57. The standard deviation shows that the distribution of thefts was extremely uneven. The study area had over 430 cases of theft, 30 percent of which were in Zone 19 (the red zone in Figure 18). After contacting the Gonzaga Campus Public Safety and Security Office, I found that these 143 crimes of theft were not reported by exact location. While the victims could not nail down the specific location in the campus area, Spokane police usually marked College Hall as the crime location (located in Zone 19). Hence, all of the crime data for the Gonzaga campus area are questionable. For the accuracy of the next data analysis, this study only employs the data which is outside the campus, eliminating the uncertain data within the campus.
5.5 Analysis of Correlation between Observation and Crimes

After confirming the accuracy of crime data from the Gonzaga Campus Public Safety and Security Office, it was revealed that campus crimes were mostly reported in the College Hall area (Zone 19), even though the crimes may have occurred somewhere else. Therefore, as noted above, the study excludes the zones for the campus area and uses the remaining zones which include Zones 1 to 8, Zone 16 and Zone 31. In addition, all the ratings of CV and EN in the outside campus areas are 0, so these two factors are excluded from the analysis. Thus, the remaining nine environmental factors and one comprehensive factor are testable in the following data analysis (see Table 5). Table 6 illustrates the numbers of crimes within different types of crimes in these 10 zones.

### Table 5: On-site Survey in 10 Zones

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<td>0</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.75</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Min</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.25</td>
<td>0.25</td>
<td>0.5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Max</td>
<td>1</td>
<td>0.75</td>
<td>0.25</td>
<td>0.25</td>
<td>0.75</td>
<td>1</td>
<td>0.75</td>
<td>1</td>
<td>1</td>
<td>5.625</td>
</tr>
<tr>
<td>Mean</td>
<td>0.6</td>
<td>0.375</td>
<td>0.075</td>
<td>0.075</td>
<td>0.225</td>
<td>0.725</td>
<td>0.525</td>
<td>0.75</td>
<td>0.525</td>
<td>3.875</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.327</td>
<td>0.243</td>
<td>0.121</td>
<td>0.121</td>
<td>0.275</td>
<td>0.249</td>
<td>0.249</td>
<td>0.204</td>
<td>0.299</td>
<td>0.959</td>
</tr>
</tbody>
</table>

Source: Author.

Table 6: Numbers of Crimes in 10 Zones

<table>
<thead>
<tr>
<th>Crime Zone</th>
<th>Assault</th>
<th>Burglary</th>
<th>Robbery</th>
<th>Theft</th>
<th>Total Crimes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>
5.5.1 Correlation Coefficient Statistics

Correlation coefficient is employed for this study. Pearson product-movement correlation coefficient is a numerical index that examines the relationship between two variables. It allows this researcher to understand whether environmental factors and crimes tend to move in the same or opposite directions when they change. The way to interpret the value of the correlation coefficient is by eyeballing and using Cohen’s (1988) criteria (see Table 7 below). A correlation can range in value from -1 to 1. The absolute value of the coefficient reflects the strength of the correlation. For example, a correlation of -0.5 is stronger than a correlation of +0.3. The small letter $r$ represents the Pearson product-movement correlation coefficient. $r_{xy}$ is the correlation between variable $X$ and variable $Y$. Positive values indicate a relationship between $x$ and $y$ variables such that as values for $x$ increases, values for $y$ also increase. Negative values indicate a relationship between $x$ and $y$ such that as values for $x$ increase, values for $y$ decrease. In this
study, for example, \( r_{\text{SL-assault}} \) is the correlation between street lighting and the crime of assault. 

The Excel Spreadsheet Program was used to calculate the actual strength of the relationship between two data sets. Table 8 shows a summary of the relationships between environmental factors and crimes.

### Table 7: Interpretation of the Size of a Correlation

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Negative</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Relationship</td>
<td>-0.09 to 0.0</td>
<td>0.0 to 0.09</td>
</tr>
<tr>
<td>Weak Relationship</td>
<td>-0.3 to -0.1</td>
<td>0.1 to 0.3</td>
</tr>
<tr>
<td>Moderate Relationship</td>
<td>-0.5 to -0.3</td>
<td>0.3 to 0.5</td>
</tr>
<tr>
<td>Strong Relationship</td>
<td>-1.0 to -0.5</td>
<td>0.5 to 1.0</td>
</tr>
</tbody>
</table>


### Table 8: Correlation Matrix of Environmental Factors and Crimes

<table>
<thead>
<tr>
<th>Factor/Crime</th>
<th>SL</th>
<th>SH</th>
<th>TR</th>
<th>BU</th>
<th>LO</th>
<th>WB</th>
<th>FL</th>
<th>FE</th>
<th>SI</th>
<th>TOT AL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assault</td>
<td>0.106</td>
<td>0.607</td>
<td>0.205</td>
<td>0.576</td>
<td>0.469</td>
<td>0.062</td>
<td>0.524</td>
<td>0.404</td>
<td>0.179</td>
<td>0.633</td>
</tr>
<tr>
<td>Burglary</td>
<td>-0.559</td>
<td>-0.441</td>
<td>0.225</td>
<td>-0.485</td>
<td>0.244</td>
<td>-0.189</td>
<td>-0.499</td>
<td>-0.210</td>
<td>-0.415</td>
<td>-0.617</td>
</tr>
<tr>
<td>Robbery</td>
<td>0.191</td>
<td>0.578</td>
<td>0.054</td>
<td>0.411</td>
<td>0.306</td>
<td>-0.096</td>
<td>0.703</td>
<td>0.106</td>
<td>0.368</td>
<td>0.653</td>
</tr>
<tr>
<td>Theft</td>
<td>0.142</td>
<td>0.684</td>
<td>-0.273</td>
<td>0.538</td>
<td>0.477</td>
<td>-0.029</td>
<td>0.391</td>
<td>0.441</td>
<td>0.169</td>
<td>0.633</td>
</tr>
<tr>
<td>Total Crimes</td>
<td>0.099</td>
<td>0.642</td>
<td>-0.228</td>
<td>0.526</td>
<td>0.501</td>
<td>-0.055</td>
<td>0.471</td>
<td>0.427</td>
<td>0.156</td>
<td>0.606</td>
</tr>
</tbody>
</table>

Source: Author.

5.5.2 Display of Correlation by Scatter Plot Graphs

The use of Excel Spreadsheet Program (see Table 8 above) and Scatter Plot graphs in Excel (see Figures 19-28 below) represent the relationship of environmental factors and crimes. The scatter
plot graph includes several data points and a regression line. The points are scattered about the line to show every change. The closer the data points are to the line, the stronger effect one variable has on the other. If the line increases from left to right, it means a positive correlation in the data. But if the line decreases from left to right, it means there is a negative correlation. In Figures 19-28, dark blue data points and lines stand for assault, red data points and lines stand for burglary, green data points and lines stand for robbery, purple data points and lines stand for theft, and light blue data points and lines stand for total crimes.

5.5.3 Analysis of Correlation by Excel Spreadsheet Program and Scatter Plot Graphs

The analysis of the correlation of each factor and crime is below:

**Street Lighting (SL):** $r_{SL\text{-assault}}$, $r_{SL\text{-theft}}$, and $r_{SL\text{-total crimes}}$ in Table 8 are around 0.1. The data points in Figure 19 look like a shotgun blast, so there are no correlations. $r_{SL\text{-robbery}}$ is 0.192, and the points are close to the line, so they have a weak but positive correlation. $r_{SL\text{-burglary}}$ is -0.559 and the points are clustered along the trend line, but the slope decreases from left to right. Thus, street lighting has a strong but negative correlation with burglary.

**Shrubbery (SH):** $r_{SH\text{-assault}}$, $r_{SH\text{-theft}}$, $r_{SH\text{-robbery}}$ and $r_{SH\text{-total crimes}}$ in Table 8 are more than 0.5. The points in Figure 20 are mostly close to the lines, so they have strong and positive correlations. However, $r_{SH\text{-burglary}}$ is -0.441 and a majority of points are close to the line which decreases from left to right. Thus, the correlation is not very strong and negative.

**Trees (TR):** The absolute correlation values in Table 8 are all less than 0.3. Most of the points in Figure 21 are far away from the lines. $r_{TR\text{-assault}}$, $r_{TR\text{-theft}}$, and $r_{TR\text{-total crimes}}$ have negative values. Their lines decrease from left to right, so they have the weak and negative correlations. $r_{TR\text{-burglary}}$ is 0.225, so the correlation is very weak. For $r_{TR\text{-robbery}}$ is 0.054, there is no correlation.
**Orientation of Building (BU):** \( r_{\text{BU-assault}} \), \( r_{\text{BU-theft}} \), and \( r_{\text{BU-total crimes}} \) in Table 8 are more than 0.5. The data points in Figure 22 are distributed evenly on the ends of the lines, so they have strong and positive correlations. However, the absolute values of \( r_{\text{BU-robbery}} \) and \( r_{\text{BU-burglary}} \) are around 0.4-0.5. The correlation of BU and robbery is positive and not too strong. However, the line of BU with burglary decreases from left to right, so the correlation is moderate and negative.

**Deadbolt Lock (LO):** \( r_{\text{LO-total crimes}} \) is 0.501. The points in Figure 23 are mostly distributed evenly on the upper side and lower side of the lines, so they have strong and positive correlations. \( r_{\text{LO-assault}} \), \( r_{\text{LO-robbery}} \) and \( r_{\text{LO-theft}} \) are between 0.3-0.5, and their points are clustered along their lines. Their correlation is moderate and positive. \( r_{\text{LO-burglary}} \) is lower than 0.3, and most of the points are close to the line, so the correlation is not strong but positive.

**Window Bars (WB):** The absolute value of each correlation in the column WB of Table 8 are all less than 0.3. In Figure 24, the line decreases from left to right and some of points are distributed unevenly on two sides of the lines. Thus, their correlations are weak and negative.

**FloodLights (FL):** \( r_{\text{FL-assault}} \) and \( r_{\text{FL-robbery}} \) in Table 8 are more than 0.5. In Figure 25, their points are distributed evenly on the ends of the lines, so they have strong and positive correlations. \( r_{\text{FL-theft}} \) and \( r_{\text{FL-total crimes}} \) are lower than 0.5 and some of their points far away from the lines, so the correlations are not strong and positive. However, \( r_{\text{FL-burglary}} \) is -0.499 and a majority of points are close to the line which decreases from left to right, so the correlation is strong but negative.

**Fences (FE):** \( r_{\text{FE-assault}} \), \( r_{\text{FE-theft}} \), and \( r_{\text{FE-total crimes}} \) in Table 8 are less than 0.5 but more than 0.4. In Figure 26, some of points are close to their lines while some of them are far away from the lines, so they have positive and moderate correlations. \( r_{\text{FE-robbery}} \) is 0.106, and some points are close to the line, so the correlation is weak and positive. \( r_{\text{FE-burglary}} \) is -0.210 and the line decreases from left to right. Several points are on the line and some are scattered from it, so the correlation not
very strong and negative.

**Signs (SI):** The absolute correlation values in the column SI of Table 8 are all less than 0.5. In Figure 27, the lines of $r_{SI-assault}$, $r_{SI-theft}$, $r_{SI-robbery}$ and $r_{SI-total crimes}$ increases from left to right. The points are distributed dispersedly, so they have weak and positive correlations. Conversely, $r_{SI-burglary}$ is -0.415 and a majority of points are close to the line which decreases from left to right, so the correlation is moderate and negative.

**Comprehensive Factors (TOTAL):** The absolute correlation values in the column TOTAL of Table 8 are all more than 0.5. $r_{TOTAL-assault}$, $r_{TOTAL-theft}$, $r_{TOTAL-robbery}$ and $r_{TOTAL-total crimes}$ have positive value. In Figure 28, their points are mostly distributed evenly to the two sides of the lines, so they have the strong and positive correlations. However, $r_{TOTAL-burglary}$ has negative value since the line decreases from left to right. The majority of points are close to the line, so the correlation is strong but negative.
Figure 19. Scatterplot of street lighting and crimes

Figure 20. Scatterplot of shrubbery and crimes.

Figure 21. Scatterplot of tree and crimes.

Figure 22. Scatterplot of building orientation and crimes.
Figure 23. Scatterplot of deadbolt lock and crimes.

Figure 24. Scatterplot of window bar and crimes.

Figure 25. Scatterplot of flood lighting and crimes.

Figure 26. Scatterplot of fence and crimes.
5.6 Limitations of the Research

The first limitation of the study is the accuracy of the crime data. Regarding the response of the Gonzaga Campus Public Safety and Security Office, the crime data for the campus area was problematic. Spokane police usually reported the crime location as occurring at College Hall while they cannot confirm the exact crime spot. The second problem facing the research is small sample size. The research area should be limited from 31 zones to 10 zones in terms of data precision. The other 21 zones are parts of the campus area which could not be counted in. Thus, the smaller sample size may affect the reliability of this study.

5.7 Discussion of Findings

From the data illustrated in Table 8, the following findings are separated into two categories: one is analyzed from each row of Table 8, while another is analyzed from each column of Table 8.

5.7.1 From each row of Table 8, the correlations between separate types of crimes and all the
Assault: SH, BU, FL and TOTAL all have a strong positive correlation with assault. Newman, Crowe, Nasar and Jones, and Hillier considered that shrubbery has a significant effect on crime. The research data support this assertion. Tall shrubbery could be a good spot for an assaulter to attack others without being noticed. The more shrubs higher than 3 feet on the street or above the window sill in front of the houses, the more assaults appear. Jacobs (1961), Newman (1972), Crowe (2000) and Hillier (2008) suggested that building toward the street can increase more “eyes on the street”, so that many neighbors can watch the street and prevent criminal attacks on pedestrians to some extent. Thus, the present data supports the previous theories on building orientation.

A number of criminologists and urban designers believe that good lighting can enhance the feeling of safety and reduce potential crime. Offenders prefer dim or dark places because it will be hard for residents to notice offenders and recognize their faces. Most of the zones between Sinto Ave. and Sharp Ave. do not have streetlights, but a few well-placed flood lights are installed on houses and apartments. Thus, installing more flood lights could help to brighten the environment around the houses and even the nearby streets. According to the data, the combination of all environmental factors may influence the level of actual assault. Although some of the factors such as street lighting, trees, window bars and signs may individually have a small effect on reducing opportunities for assault, all factors together may influence each other and have greater strength to deter assault.

Burglary: SL and TOTAL has a strong but negative correlation with burglary. Clark (2000) explained that burglaries can be reduced by darkness as a result of the attention-drawing factor, e.g. when a burglar has to use hand-held lights such as matches or torches (flashlights) to see
well enough to break in. So burglars are more easily detected in a dark place. Although the causes of the negative relationship with burglary and multiple factors are unclear, a possible explanation is that the study area is very close to campus. Most of the houses and apartments are rented by students. Burglars are likely to look for things which are easy to carry and exchange for cash, such as cash, laptops, video game accessories, and iPods. Besides, the students sometimes lack vigilance and forget to secure their doors and windows when they go out. Regarding to these reasons, even if all these environmental factors were in good condition, the zones still attracted more burglars, especially professional and skillful ones.

**Robbery:** SH, FL and TOTAL all have a strong positive correlation with robbery. The correlation of the research data supports previous understandings of shrubbery. Low shrubbery could prevent the potential robber hiding behind it and facilitate residents’ observance of the surrounding environment. Flood lights are also significant for robbery prevention. It can lighten the walkways around the house and deter loitering and robbery. Almost all factors have positive correlations with robbery. The more environmental factors that are involved, the less opportunity of robbery take place. The correlation between multiple factors and robbery support the principles of environmental crime prevention theories.

**Theft:** SH, BU and TOTAL all have a strong positive correlation with theft. The correlation of shrubbery with theft supports the view of previous theories. Low shrubbery provides no hiding places and facilitates residents’ observance of the surrounding environment. Also, the present data supports the previous theories on building orientation. Buildings facing toward the street can increase more “eyes on the street” in order to increase natural surveillance by residents and promote greater perception of risk by thieves. The correlation between the combination of factors and theft supports the principles of environmental crime prevention theories. The physical
elements together may produce behavioral effects that reduce the incidence of crime.

**Total Crimes**: SH, BU, LO and TOTAL all have a strong positive correlation with total crimes. The correlation of shrubbery with total crimes supports the view of previous theories. Low shrubbery provides no hiding places and facilitates residents’ observation of the surrounding environment. Also, the view of “building toward the street” mentioned by Jacobs (1961), Newman (1972), Crowe (2000) and Hillier (2008) receives support. Buildings facing the street can increase more “eyes on the street” in order to increase natural surveillance by residents and promote greater perception of risk by thieves. Furthermore, Newman (1972) and Crowe (2000) consider that good locked gates can eliminate illegal entry attempts. The data support this concept. The correlation between the combination of factors and total crimes supports the principles of environmental crime prevention theories. Thus, properties with steady lighting, well trimmed plantings, buildings facing toward the street, strong deadbolt locks and window bars, and proper fencing and signs reduce the propensity of the physical environment to support criminal behavior.

5.7.2 From each row of Table 8, the correlations between individual environmental factors and all crimes are analyzed.

**Street Lighting (SL)**: Street lighting has a negative but strong correlation with burglary, but has a weak correlation with assault, robbery, theft and total crimes. It has been suggested that in certain situations, increased lighting may actually increase the level of property crime. Clark (2000) explained that burglaries can be reduced by darkness as a result of the attention-drawing factor, e.g. when a burglar has to use hand-held artificial lights such as matches or torches (flashlights) to see well enough to break in. Hand-held artificial light sources tend to attract
attention, so burglars are more easily found in dark places. However, crimes other than burglary are generally more difficult to commit in well-lit environments. Criminals are not too eager to stand under a bright spotlight while they plan to commit crimes.

The present data shows that correlations between lighting and actual crimes (except burglary) are weak. The assumption is that offenders may also need lighting to detect potential targets. The lighting makes the patron more visible to passing offenders. Another assumption is that some impulsive offenders won’t consider any influential factors for low-risk situations. They mainly look for easy targets. Jacobs (1961), Newman (1972), Crowe (2000) and Nasar and Jones (1992) mainly mentioned that good lighting can increase the feeling of security and potential surveillance. In short, the effectiveness of lighting is unknown. It could help to reduce fear of crime, but may not reduce actual incidence of crime.

**Shrubbery (SH):** Shrubbery has strong correlation with most of the crimes except burglary. The research data shows that the more proper the height of shrubbery, the less numbers of crimes occur. A study conducted by Kuo and Sullivan (2001) indicated that vegetation reduces mental fatigue which would decrease crime as aggression levels decreased. In addition, Crowe considered that lower shrubbery can increase surveillance and reduce cover which increases the risk to criminals. However, shrubbery has a moderate but negative impact on burglary. It could be the reason that heavily dense shrubs may affect the incidence of burglary, even though the heights of shrubs are low. In addition, the distance between residences and on street shrubbery is further than that between pedestrians and shrubs. Thus, indoor residents may find it difficult to detect burglars while the offenders are hiding in the dense street-side shrubs.

**Trees (TR):** There was weak or no correlation between tree and crimes. Although Crowe (2000) considered that well trimmed trees can enhance surveillance and reduce cover, the current data
fail to support his view. There could be a simple explanation for the fact that most road trees are rather tall and have fewer branches, so they rarely influence visibility or create the hiding spots. Potential criminals may look for other hiding places such as dense bushes and shrubs. Thus, trees are not significant for crimes, but shrubbery is.

**Orientation of Building (BU):** Assault, theft and total crimes all have a strong and positive correlation with the orientation of building. Jacobs, Newman, Crowe and Hillier considered that buildings facing toward the street can encourage surveillance and reduce crime. The present data support their thoughts.

**Deadbolt Locks (LO):** Deadbolt locks have a strong correlation with total crimes, but not with assault, burglary, robbery and theft. CPTED asserted that deadbolt locks can provide good protection and target hardening. It is reasonable that assault, robbery or theft have a moderate correlation with deadbolt locks, because they mostly occur outside of houses. Although the relationship between burglary and deadbolt locks is weak with a correlation of 0.244, it still shows that the more deadbolt locks, the less burglaries occur. The possible reason for their weak relationship is that specialized burglars can break locks rather easily with tools after doing rigorous planning. So no matter how good qualities the deadbolt locks have, burglars have a way to break them in a few minutes. However, the effectiveness of deadbolt locks is uncertain. It’s questionable that deadbolt locks do not have a very strong correlation with individual crime, but it has strong correlation with total crimes. \( r_{LO-assault} \) and \( r_{LO-theft} \) are close to 0.50 which can be seen as they having a strong relationship. \( r_{LO-total\ crimes} \) is 0.50. The number of crimes may complement others. Thus, even though deadbolt locks have a small influence on each crime, there is still an impact on total crime.

**Window Bars (WB):** Window bars have no correlation with assault, robbery, theft and overall
crime. Because these types of crimes mostly occur on the street, instead of inside of the house, window bars could not influence them. Also, window bars have a very weak negative correlation with burglary. The reason is probably because there were only a few numbers of burglaries committed in the study area, so those could be seen as impulsive burglaries. Impulsive burglars are often into drug-use and look for cash or valuable items. They break into a house without plans or consideration of any factors which may obstruct their behaviors. Even if the shop or house has window bar installed, impulsive burglars may use a hammer or other tools to remove it at late night or early morning, then grab and smash something valuable.

**FloodLights (FL):** Flood lighting has a strong correlation with violent crime, including assault and robbery. Residents are more likely to see the crime occur and recognize the person committing the crime in a well lit area. Criminals tend to commit crimes in dark and poorly lit areas. But most of the zones (Zones 1-8) do not have streetlights, so buildings and housing with flood lights can increase safety and security after dark. Since the zones with more flood lights had less chance of violent crimes, the view of CPTED on flood lighting is supported. However, burglary is the exception for the view of CPTED on flood lighting. With the similar reason as street lighting, burglaries can be reduced by darkness because of the attention-drawing factor.

**Fences (FE):** None of the crimes has a strong correlation with fences. Newman and Crowe consider that fences can provide clear definition of controlled space and discourage trespass by potential offenders. The present research fails to support their opinion. Most of the crimes such as assault, robbery and theft are committed on the street. Fences are mostly installed in front of the yard or around the house. So fences may not have a tight relationship with these kinds of crimes. Fences also have a weak and negative correlation with burglary. There are several types of fences in the study zones, such as chain-link fences, wire netting fences, wooden fences and
concrete fences. It is probable that burglars seldom care about the fences because they are easy to climb over. Another probability is that burglars may think a house with fencing must store more valuables inside. It may actually motivate burglars to break into the structure.

**Signs (SI):** None of the crimes has a strong correlation with signs. There are stop signs, speed limit signs, yard signs, street name signs and school pedestrian signs in the research area. Stop signs, speed limit signs and school pedestrian signs may have an effect on traffic crimes which are not considered in this study. Crowe (2000) and Nasar and Jones (1997) believe signs can raise feelings of security. But they did not mention that signs can influence actual crime. Most criminals may not notice and be deterred from committing crimes because of the meaning of the signs. Hence, it is possible that signs do not have much relation with actual crimes, but may have some effect on fear of crime.

**Comprehensive Factors (TOTAL):** The multi-environmental factor has a strong correlation with each crime. The relationships between assault, robbery, theft or total crimes and comprehensive factors are positive. They support prior theories indicating that environmental factors can decrease the risk of crimes. The combination of factors reinforces the effectiveness of deterring crimes. The pattern of burglary is different from other types of crimes. As explained before (see 5.7.1 burglary), burglary may have a negative relationship with environmental factors.

5.8 Conclusions

From the above analysis, it is evident that there is a definite relation between environmental factors and crimes. The multiple factor has proven, in this case study, to have a strong impact on crimes. Although the relationship with burglary is negative, the correlation with other crimes such as assault, robbery, theft and total crimes are positive. It is also evident that some
environmental factors, especially shrubbery, the orientation of the building and flood lights, can reduce most crimes. Other factors such as street lighting, trees, window bars, fences and signs have little impact on crime. Furthermore, CCTV and the number of building entrances are not testable in this study. In conclusion, this research supports some of the tenets of previous environmental theories and studies.
6.1 Conclusions

Environmental design has proven to be useful in preventing crimes. This study involves the assumption that crime patterns are not uniformly distributed depending on relevant environmental factors. The result of the study demonstrates that some of the environmental factors have a strong impact on crimes, while others do not.

This research provides a general understanding of crime and its relationship with the physical environment. The understanding involves the idea that criminal events can be prevented by environmental designs that alter the situation to make crimes more risky and targets less attractive for attack by potential criminals. There have been previous attempts to link landscape and architectural design with crime prevention, the most publicized of which are Jacobs’s “Eyes on the Street”, Newman’s Defensible Space, Crowe’s Crime Prevention through Environmental Design (CPTED), Appleton’s Prospect-Refuge Theory, and Hillier’s Space Syntax Theory. Among these five theories, all mentioned the usefulness of street lighting; four theories mentioned the value of vegetation and building design; three theories mentioned the setting of paths, outdoor walls and seating; one or two theories mentioned the usage of windows, doors and locks, fences, signs and public video surveillance, etc. Moreover, in recent years, several environmental elements, including lighting, vegetation, public video surveillance, building design, fences and signs, have been evaluated for their effectiveness of crime prevention in a number of studies. However, there is no reliable evidence that lighting and vegetation using CPTED’s standard reduces actual crimes. Also, the significance of fences and signs to prevent crime has rarely been ascertained. Hence, the relationships of different physical elements with the incidence of crimes need to be evaluated.
For the purposes of this research, 11 physical factors in and around Gonzaga University, Spokane, Washington were examined. 31 zones were divided by blocks in the study area. The on-site rating standards for these factors were selected based on the tenets of five environmental crime prevention theories. The actual crime records were collected from the Spokane Police Department for the period 2/1/2005 to 4/30/2010. Using correlation coefficient statistics, the correlations of environmental factors and actual crimes were examined. The results show that the physical factors have diverse relationships with different types of crimes.

1) Street lighting has little influence on actual crimes except for burglary. The correlation between street lighting and burglary is negative. Therefore, street lighting as called for by Jacobs (1961), Newman (1972), Crowe (2000), Nasar and Jones (1992) and Hillier (2008) does not receive any support. Also, CPTED’s lighting standard, “street lighting should make people identify others’ face within 50 feet”, has little impact on crimes in this case.

2) Shrubbery has a strong relationship with assault, robbery, theft, and total crimes. This correlation highly supports the views by Newman (1972), Crowe (2000), Nasar and Jones (1992) and Hillier (2008). Especially, the standard of shrubbery on CPTED, “shrubbery should be trimmed below 3 feet or at least below the window sill”, has an impact on most of the crimes which include assault, robbery and theft.

3) Trees show little influence on crimes. So, the idea of trees of CPTED and SBD, i.e., “tree limbs need to be at least 6 feet from the ground”, receives limited support.

4) The orientation of buildings has strong correlation with assault, theft and total crimes. Thus, the idea of “building facing toward the street” called for by Jacobs (1961), Newman (1972), Crowe (2000) and Hillier (2008) has good support.
5) Deadbolt locks have a moderate correlation with four kinds of crimes, while there is strong correlation with total crimes. The view that a “good locked gate can eliminate illegal entry attempts” referred to by Newman (1972) and Crowe (2000) is not fully supported. The reason is uncertain why deadbolt locks have small impact on each crime, but there is stronger influence on total crimes.

6) Window bars have little influence on crimes. So the idea of window bar on CPTED receives limited support.

7) Flood lighting has a strong correlation with assault and robbery. As a result, the idea of flood lighting on CPTED is supported by the data.

8) Fencing has moderate or weak correlation with individual crimes, but it has strong correlation with total crimes. Therefore, the effectiveness of fencing as called for by Newman (1972) and Crowe (2000) is uncertain.

9) Signs have moderate or weak correlation with crimes. Thus, the view of signs put forward by Crowe (2000), and Nasar and Jones (1997) receives limited support.

10) CCTV and the number of building entrances are not testable in the study. The effectiveness of these two factors with crimes is uncertain.

11) The combination of all factors has strong positive correlation with assault, robbery, theft and total crimes, while there is strong negative correlation with burglary. This relationship supports the assertion by CPTED that environmental approaches can influence the incidence of crimes.

In conclusion, this study supports the understanding that shrubbery, the orientation of the building and flood lights have an impact on crimes. This study has limited support for other individual factors such as street lighting, trees, window bars, fences and signs. However, if
carefully design for site features (such as properties with steady lighting, well trimmed plantings, buildings facing toward the street, strong deadbolt locks and window bars, and proper fencing and signs), some crimes may be minimized.

6.2 Recommendations for Future Research

This study has only focused on the area in and around Gonzaga University. The sample size was limited. In order to provide a wider range of findings, future research may be conducted in other campus neighborhoods in Spokane or other American cities, and comparisons can be made. In other future research, it can be considered to compare the environmental factors of neighborhoods close to campus and neighborhoods with no campus nearby. In addition, research zones can be broken down by ½ block or alley to identify which environmental elements affect specific crime. Comparisons between these case studies will produce more intelligible results.
REFERENCES


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