Exploring Places of Street Drug Dealing in a Downtown Area in Brazil: An Analysis of the Reliability of Google Street View in International Criminological Research

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Abstract: This study assesses the reliability of Google Street View (GSV) in auditing environmental features that help create hotbeds of drug dealing in Belo Horizonte, one of Brazil's largest cities. Based on concepts of "crime generators" and "crime enablers," a set of 40 items were selected using arrest data related to drug activities for the period between 2007 and 2011. These items served to develop a GSV data collection instrument used to observe features of 135 street segments that were identified as drug dealing hot spots in downtown Belo Horizonte. The study employs an intra-class correlation (ICC) statistics as a measure of reliability. The study showed mixed findings regarding agreement on some features among raters. One on hand, the observer's lack of familiarity with the local culture and street dynamics may pose a challenge with regards to identifying environmental features. On the other hand, factors such as image quality, objects that obstruct the view, and the overlooking of addresses that are not officially registered also decrease the reliability of the instrument. We conclude that a combination of tools and strategies should be applied to make the use of GSV truly reliable in the field of international criminological research.

Keywords: Google Street View, Gangs, Policing, Brazil, Violence.

INTRODUCTION

This study assesses the reliability of Google Street View (GSV) for international research in the field of criminology. For the purpose of this study, GSV has been employed to observe environmental features that help to create street drug markets at specific addresses in the city center of Belo Horizonte, one of Brazil's largest cities. Questions often arise concerning the participation of observers who are not familiar with the local culture or do not have prior knowledge of the terrain of the area that is being assessed. Some features seem to be universally conceptualized and appear to be easily measured by an outside observer. This includes features of recreational facilities, features of buildings, and characteristics of land use, while other features and characteristics might be susceptible to cultural bias and misinterpretation. This could lead to compromising the observer's ability in being able to make an accurate assessment.

This paper examines two important research questions. Firstly, is GSV a reliable instrument for the use of collecting international and comparative environmental data on crime hot spots? Secondly, does prior knowledge of the study area result in a reliable assessment of the environmental features of crime hot spots? The study employs an intra-class correlation (ICC) as a measure of reliability and it is aimed at providing recommendations for the better use of GSV in data collection abroad.

The use of GSV is still relatively new in the field of criminology and it has not been applied as much as it has in other fields, such as epidemiology, geography, or public health (Vandeviver 2014). However, despite that fact, it has been proven to be a promising tool by scholars who are interested in examining the relationship between neighborhood features and variations on crime rates such as the pioneer study conducted by Odgers *et al*. (2012) on the association between risk environment and anti-social behavior in children in England and Wales. In the U.S., a pioneer use of the GSV tool for data collection is the research conducted by Fujita (2011) on the association between environmental features and auto-theft in Newark, NJ. Following this study, Hsu (2014) tested the reliability of GSV to observe situational and environmental variables of street drug markets in Newark. Additionally, Hsu and Miller in 2017 employed the GSV tool in a novel way by examining and comparing the differences and similarities of situational factors between drug dealing hot spots at a street-and-intersection-level of analysis. An even more recent study conducted by He *et al*. (2017) used a GSV-based environmental audit to analyze the relationship between features of the built environment of residential blocks and violent crime in an urban American city using the Poisson regression model. Despite the advancement of criminological research employing

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E-ISSN: 1929-4409/18

GSV, no research has examined its reliability in observing the environmental factors leading to crime in the streets at an international level until this current study. Would similar features of physical and built environment used to measure hot spots of street drug markets in American cities be conceptualized similarly in the diverse context of urban centers abroad? Would the local interpretation of environment features impact the reliability of GSV in collecting data for international criminological research?

This paper offers some valuable and groundbreaking discoveries. To begin with, it is virtually a pioneer by using Google Street View to explore environmental mechanisms that contribute to create hot spots for drug dealing in Brazil. There is no doubt that the use of crime mapping technology and victimization surveys have contributed to the growth of ecological studies on the association between hot spots of drug markets and violence among local scholars (Silva *et al*. 2013; Beato Filho *et al*. 2001). Additionally, local crime experts have also focused on explaining the complex relationship between perceptions of fear of crime related to physical and social disorder and its association with indicators of social cohesion and collective efficacy in Belo Horizonte (Silva and Beato, 2013). Although there has being much progress in examining the relationship between environmental features and crime in Brazil, the use of GSV in the field of criminology is still in its initial stages.

Secondly, this current study is innovative in applying the GSV on an international level in order to assess its reliability in capturing mechanisms that might be subjected to cultural and local interpretations. Previous virtual environmental audits are using a crowd sourced database comprised of thousands of GSV imagery in order to quantify, compare, and predict perception of the urban environment across cities worldwide (Salesses *et al*. 2013). The current study has a slightly different approach as GSV is used as the main tool to observe and collect situational variables at specific addresses which have been identified as drug dealing hot spots in a Brazilian city. As for such, it contributes to the advancement of research using GSV.

GSV was implemented in Brazil on 30 September 2010, making Brazil the first country in South America where GSV became publically available; the majority of the country has been mapped including Belo Horizonte, which is the technological center of Google in Brazil (Google 2017). Yet Brazilian law enforcement has traditionally not taken into account the influence of the environmental mechanisms in explaining hot spots of crime, and thus has not capitalized on the data available through GSV. This study advocates the use of this novel tool by law enforcement, especially in Brazil.

This current study follows the tradition of environmental criminology to select a sub-set of 40 items to be included in a GSV data collection instrument used to observe features of 135 street segments that were identified as drug dealing hot spots in the downtown area of Belo Horizonte, which is the state capital of Minas Gerais. This allows for detailed observation of the features of these places and accurate assessment of the reliability of GSV which is tested through an inter-rater reliability check using multiple raters, both inside and outside the United States. The study concludes with the results of an inter-rater reliability check and recommendations for future international research using GSV as the main tool for conducting online auditing surveys.

GOOGLE STREET VIEW: A PROMISING DATA COLLECTION TOOL IN THE FIELD OF CRIMINOLOGY

Google Street View (GSV), a relatively new technology integrated in Google Maps and Google Earth, allows us to explore the world virtually, providing 360º horizontal and 260º vertical high definition images of physical and environmental features at street level (Vincent 2007; Vandeviver 2014). In the vast field of empirical research, GSV has raised new questions on how and why environmental characteristics on the streets impact an individuals' decision making process, behavior, attitude, and perceptions. As a result, it has been widely tested and applied, particularly by geographers, biologists, epidemiologists, archeologists, and social scientists, and more recently by criminologists (Vandeviver 2014).

According to Vandeviver (2014) various studies have indicated numerous advantages to using Google Street View to gather and visualize environmental information on animal species (Olea and Mateo-Tomás 2013), population (Rousselet *et al*. 2013; Gordon and Janzen 2013), pedestrians and road infrastructure (Hanson *et al*. 2013; Guo 2013), and the built and social environment (Sampson 2013), as well as crime incidents in a specific area by law enforcement agencies.

GSV has been proven to be more cost-effective as well as time-effective as opposed to collecting data in

person (Brownson, Chang, Eyler, Ainsworth, Kirtland, Saelens, and Sallis 2004; Pringle 2010; Kennedy and Bishop 2011; Clarke, Melendez, and Morenoff 2010; Hsu 2014; Hsu and Miller 2017). It also ensures the observers' safety, as they do need to expose themselves to a dangerous environment. Additionally, studies have shown that GSV also facilitates research in its capacity to systematically assess the accuracy and objectivity of the data collection process (Vincent 2007; Clarke *et al*. 2010; Shet 2014). As a result, these studies show that documentation of images by GSV contributes to the examination of environmental changes over time and subsequently to the progress of longitudinal studies. In addition, GSV has addressed ethical issues related to the tool's intrusiveness to individuals' privacy and properties as the use of images of individuals' face as well as license plates have been blurred (Google [2014h]).

Researchers have tested the feasibility of the GSV tool by using a variety of models including inter-rater as well as intra-rater reliability tests. A few researchers have also conducted an inter-reliability test of the GSV by comparing the results of internet-based neighborhood audits to an actual in-person neighborhood audit conducted by individuals (Clarke *et al*., 2010). These studies have proven that GSV is a reliable observational tool in measuring particular features of the built environment (e.g., retail stores, gas stations, and restaurants) and landscape use (e.g., residential, recreational, public ways, and transport locations) (Kelly, Wilson, Baker, Miller, and Schootman 2013; Hsu 2014). Nevertheless, concerns regarding to what extent GSV is a reliable tool in accurately capturing signs of physical disorder, which can be minute and subject to temporal patterns, have been raised. Examples of these signs of disorder include: litter, loitering, drug paraphernalia, and social disorder (e.g., drinking in the street and soliciting prostitutes) (Rundle, Bader, Richards, Neckerman, and Teitler 2011).

Yet, the use of GSV has not been applied as a major instrument to measure environmental data in international and comparative criminological research. It has being perceived as a promising tool, particularly in the study of crime in neighborhoods as well as in the field of Environmental Criminology. According to Vandeviver 2014, there is a major issue related to the reliability of employing GSV to measure characteristics of neighborhoods for international and comparative research purposes. Questions arise concerning the participation of observers who are not familiar with the culture or do not have a prior knowledge of the terrain of the area that they will assess; while some features that seem to be universally conceptualized and appear to be easily measured by an outside observer, such as features of recreational facilities, features of buildings, and land use, other features might be susceptible to cultural bias and misinterpretation, compromising the observer's ability to make an accurate assessment. Following this new line of research, this paper addresses the feasibility of using GSV in international research with the goal of identifying its main challenges as well as providing recommendations for a better use of this virtual tool in data collection abroad.

In order to contribute to filling the gap on the use of GSV in international criminological research, this current study employs GSV to observe and collect data on features of drug dealing hot spots in the city center of Belo Horizonte, Brazil.

BACKGROUND

Belo Horizonte is comprised of 2,523.794 inhabitants and occupies an area of 335 Km2. It is comprised of 487 neighborhoods, including 215 *favelas vilas* (improved favelas) and public housings, as well as the city center inhabited by a population of 14, 399, more than 1% of the entire city's population (*Instituto Brasileiro de Geografia e Estatistica*—IBGE 2010 Census).

Belo Horizonte was inaugurated in 1893, and grew at a high rate through the process of industrialization reaching its peak in the 1970s (Arreguy and Ribeiro 2008).This resulted in a disorderly urban growth marked not only by the formation of numerous favelas next door to wealthy and middle class neighborhoods, but also to the falling apart of the downtown area. Residential homes, typical in the landscape of the city center, in the beginning of the 20th century were torn down and replaced by modern skyscrapers and apartment buildings. However, with a large population moving into the downtown area alongside its former residents, the city became saturated by the 2000s.

According to Arreguy and Ribeiro (2008), this shift in population created many problems leading to a non-coherent leaving situation among its residents. Non-licensed street vendors, the homeless population, beggars, and abandoned youths took over the streets and crime was on the rise. Additionally, crime and violence were on the rise, particularly related to the problem of illegal drug activity which traditionally

prevails in impoverished and socio-disorganized urban environments of *favelas* in large Brazilian cities (De Souza 2010; Oliveira 2012; Sapori, Sena, and Silva 2012; Beato and Zilli 2012; Silva 2014; Oliveira, Silva, and Prates 2015). Embedded in the disorderly landscape of these communities, and hidden by its hilly terrain and infinite mazes of alleyways, the buying and selling of marijuana and cocaine expanded uncontrollably.

However, the boosting of the illegal commerce of drugs in favelas due to the rise of the international trafficking of crack cocaine in the late of 1990s contributed to create more visibility in open drug markets beyond favelas (Rui 2012; Salgado 2013; Oliveira *et al*. 2015). This is illustrated by *cracolandias* (cracklands) – tiny urban settings of open and intense drug activity often located in the surrounding bohemian zone traditionally well known for illegal drug activity. In Belo Horizonte *cracolandias* freely invaded specific and well-chosen intersections to main avenues in downtown areas. Concentration was also evident within covered pedestrian and vehicular ramps, near main transportation hubs, abandoned buildings, and parks as well as surrounding favelas. These are places where a diverse population of drug users and buyers congregates, including the homeless, prostitutes, roving teenagers, drunks, and the mentally challenged (Domanico 2006; Grillo 2008; Frugoli and Spaggiari 2010; Salgado 2013).

By 2002, the city center was completed revitalized with the installation of CCTV surveillance cameras to reduce criminal activities, building improvement, and the removal of street vendors and the homeless (Belo Horizonte Archives 2017). Currently, the city center modernization is challenged by a return of the homeless population, the intense activity of pedestrian and vehicular traffic, and the complex use of land combining residential and commercial buildings, educational institutions, and recreational zones along with a highly active bohemian zone where prostitutes are concentrated (Belo Horizonte Archive 2017).

The increased growth of street drug dealing during the past four decades has influenced a wave of sociological research and ethnographic studies; since the 1980s, research has aimed at explaining the association between drugs and violence in favelas as well as, more recently, addressing the new problem of the rise of *cracolandias* (Frugoli and Spaggiari 2010; Salgado 2013). Although studies have indicated that street drug markets are highly concentrated in impoverished and socially disorganized neighborhoods (Anderson 1999; Bursik 1988; Harocopos and Hough 2005; Martinez, Rosenfeld, and Mares 2008; Lipton, Yang, Braga, Goldstick, Newton and Rura 2013), this has led to "neighborhood fallacy," a misinterpretation that the composition and features of poor neighborhoods are the best predictors of crime and its patterns. Instead, previous studies in line with Environmental Criminology indicate that drug activity, as any other type of crime, is highly concentrated at micro places with special functions and environmental features (Kleiman 1991; Rengert 1996; Rengert, Chakravorty, Bole, and Henderson 2000).

THEORETICAL FRAMEWORK AND PRIOR FINDINGS

Scholars in line with Environmental Criminology indicate that street drug dealing, as with any other type of crime, is highly influenced by the immediate environmental features and opportunities presented. One of the theoretical pillars to substantiate this evidence is the Crime Pattern theory which states that variations in the built environment and the mixed use of land not only shape an individual's everyday activities and movement patterns (Brantigham and Brantigham 1993), but also create criminal opportunities by increasing the number of potential targets, lessening rules of conduct and enforcement, and escalating the operation of other situational mechanisms that generate crime (Brantigham and Brantingham 1995; Clarke and Eck 2005). Hence, hot spots of crime are concentrated in places where the social, economic, and physical backcloth produce nodes of activities, functions and mechanisms that contribute to criminal opportunities (Brantigham and Brantigham 1993; Eck and Weisburd 1995).

Suitable places for hot spots are categorized as "crime attractors," "crime generators" and "crime enablers" (Brantigham and Brantingham 1995; Clarke and Eck 2005). Areas with intense drug activity serve as an example of "crime attractors," as criminal opportunities are widely known to be available there. As a result, people highly disposed to committing crimes are easily seduced into doing so.

"Crime generators" refers to places where large numbers of people are pulled in or simply pass through without any intention of committing a crime, but in which crime opportunities exist in any case, making the temptation hard to resist. Prior research shows a strong correlation between drug markets and places that function as "crime generators" such as retail

establishments, liquor stores, bars and fast food eateries, repair shops, convenience stores, and pawnshops (Block and Block 1995; Eck 1994; McCord and Ratcliffe 2007, Rengert 1996), as well as public parks (Groff and McCord 2012; Rengert 1996). "Crime generators" for drug activity are also oftentimes places of mass transit such as major thoroughfares, transportation hubs (Rengert 1996; Caplan *et al*. 2011; Eck and Weisburd 1995; Weisburd *et al*. 2012), individual bus stops (Edmunds, Hough, and Urquia 1996; Loukaitou-Sideris 1999; Rengert *et al*. 2005), and parking lots (Brantingham and Brantingham 1995; Rengert 1996; Sussman, Stacy, Ames, and Freedman 1998).

Moreover, places where there is little regulation of behavior and weak mechanisms of guardianship and handling are defined as "crime enablers" (Clarke and Eck 2005). This includes specific building sites providing limited public surveillance and weak building management and physical security, thereby allowing easy customer accessibility. According to Eck (1994) these are places that increase the risk of becoming "crime attractors" for drug dealing.

As the concentration of criminogenic environmental mechanisms varies depending on the location, so too does the concentration of hot spots of crime and drug dealing activity. Hot spots of drug dealing are also located in areas with a high degree of social disadvantage (Kleiman 1991), including vacant lots (Branas *et al*. 2011; Myhre 2000) and abandoned buildings (Spelman 1993; Weisburd and Green 1994). Along with that we can include homeless shelters, unattended parks, and areas of easy concealment and escape routes (Conner and Burns 1991; Eck 1994; Eck and Weisburd 1995; Harocopos and Hough 2005; Myhre 2000; Rengert *et al*. 2005).

The logic of the concepts of crime generators, crime enablers, and crime attractors has guided us not only with the formulation of the main hypotheses of this study, but also with the operationalization of various indicators of environmental mechanisms used to develop a GSV data collection instrument. This instrument was inspired by the work conducted by Odgers *et al*. (2009) as well as Hsu (2014), and also includes mechanisms specific to the context of drug dealing hot spots in downtown Belo Horizonte. As per the knowledge and experience of the local police, these mechanisms were corroborated and became part of a field observation concerned with local drug dealing hot spots which was conducted by the leading author of this paper.

HYPOTHESES AND MECHANISMS

In line with Crime Pattern theory and prior research, this study states three hypotheses.

Hypothesis 1

The first hypothesis argues that the reliability of using GSV to collect data in international settings depends on the extent to which observers have prior knowledge and are familiar with the cultural aspects of the area of being explored. To test this hypothesis, a group of five raters/observers was recruited – some from Brazil and some from the U.S.

Hypothesis 2

The second hypothesis assumes that environmental mechanisms which are universally conceptualized and therefore easily identifiable are likely to receive a higher level of inter-rater agreement among raters/observers. These mechanisms include built structures, mobility mechanisms, and hidden mechanisms. Each of these mechanisms is accordingly classified as a "crime generator" or "crime enabler" and operationalized based on a classification created by Clarke and Eck (2005). To be specific:

(a) Built mechanisms are defined as any built area that represents a variation in the land use. These areas attract large numbers of people without any intention to commit crime, providing numerous opportunities for those who do intend to commit a crime. Built mechanisms are classified as "crime generators" and divided into:

- Recreational structures: These include buildings and areas where people go for entertainment and recreation. Main indicators are: public parks, bars, restaurants/fast food establishments, movie theaters, and musical theaters.
- Retail structures: These refer to buildings where people go shopping or conduct other economic trans-actions. Main indicators include shopping malls, convenience stores, banks, and liquor stores.
- Residential structures: These are buildings where people reside or stay temporarily. Main indicators are apartment buildings, homeless shelters, and hotels.

(b) Mobility mechanisms refers to any public transport system and passageways used to

navigate the downtown area. They are classified as "crime generators" and include bus stops, subway stations, train stations, public transport hubs, major thoroughfares as well as parking lots (garage/street) as the main indicators.

(c) Hidden mechanisms refer to open spaces with little regulation of behavior that facilitate the concealment of dealers' and buyers' transactions. Hidden mechanisms are classified as "crime enablers" and are facilitated in abandoned vacant lands and abandoned buildings.

One other specific item included in this category of "crime generators" is the proximity to a church. As Hsu (2014) found there is a correlation between the logistics of local churches and drug dealing spots in Newark.

Hypothesis 3

The third hypothesis assumes that other mechanisms that function as "crime generators" and "crime enablers" but are specific to the culture of Belo Horizonte, and which do not traditionally fit into other categories (previously described), are likely to receive lower levels of inter-rater agreement among raters/observers. Indicators of these mechanisms were selected based on the firsthand knowledge and practical experience of local police officers working at the Crime Analysis Unit of the Military Police in Belo Horizonte, as well as on a field observation conducted by the leading author of this paper, a Belo Horizonte native. In conducting a field observation of forty street segments identified as drug dealing hot spots, the researcher accompanied the local commander of the Military Police Crime Analysis Unit on foot patrol one Wednesday from 4:00 p.m. to 10 p.m. This time frame was used principally to identify mechanisms observed only at night and which would be difficult to code considering that GSV captures images primarily during the day. This field experience helped to determine if the same mechanisms could be applied in the same way to the street drug market as they were elsewhere in Brazil. The question was then posed whether or not there were other variables that are part of the unique fabric of Belo Horizonte which would not be easily identified by outside observers. These indicators include:

1. Motels used only for prostitution: In the U.S.A, prostitutes are often found in spas and various types of bars with designated areas for activity. These places are discretely advertised to street observers. By contrast, in the city center of Belo Horizonte, venues with the same purpose are more hidden and difficult to find unless one is familiar with them. Motels used only for prostitution are usually located in a bohemian zone of the downtown area, in highly trafficked areas and near major transportation hubs as well as wholesale outlets and small bars. Although unmarked, they can be easily detected by any attentive passerby due to the heavy traffic of men coming and going.

2. Liquor stores: Although liquor stores exist in Belo Horizonte, they are not very common. Traditionally, alcohol is purchased in non-specialized retail stores, such as supermarkets, as well as bars. In the United States, each state has its own regulations concerning the establishment and running of liquor stores.

3. Garbage collection locations, including the congregation of homeless: As the movements of the homeless vary considerably, it is virtually impossible to identify specific locations as per Google Street View. "Trash collecting point" refers to specific locations where trash is placed and collected by homeless individuals, and then sold to a local recycling cooperative.

4. Locations where non-licensed street vendors congregate: Locations where non-licensed street vendors congregate vary and would not be easily captured by Google Street View.

5. Nightclubs: Nightclubs in the city center are usually unmarked and located on the second floor of some restaurants, bars, or retail stores. Therefore, they would not be easily captured by Google Street View or even perceived by Brazilian observers who have not visited the downtown area at night.

6. Stores selling lottery tickets: Unlike in the U.S.A. where lottery tickets are mainly sold in convenience stores or liquor stores, in Brazil they are sold in specialized retail stores set up solely for the sale of lottery tickets. Although these stores could be captured by Street View image, they would probably not be easily identifiable to outside observers.

According to local police officers working as the Crime Analysis Unit, other mechanisms that might be

correlated to places suitable to drug-dealing locations in the downtown area include:

(1) Locations that are near facilities and/or areas that attract a large number of people such as: MOVE Bus Rapid System stations, barber shops, movie theaters and live entertainment facilities, high schools and colleges/universities, as well as banks.

(2) Locations that are considered potential venues for hiding illicit activities are dead-end streets, highway ramps, pedestrian ramps, and favelas as well as other rundown neighborhoods.

(3) Locations that are attractive as hangouts for youths, such as graffiti-ridden buildings and walls with murals, as well as educational facilities (i.e., high schools, colleges and universities).

A summary of all main environmental mechanisms, and indicators/items is illustrated on Table **1**. The first column of the table represents mechanisms; the second column represents two diverse types of locations – "crime generators" and "crime enablers" – that contribute to attract drug activity; the last column is divided into two categories of items. The first category represents items which are universally conceptualized; the second represented those items which, although they may also be found elsewhere in the world, were specifically defined according to the perceptions of local police as being related to hot spots of drug dealing within the specific context of downtown Belo Horizonte.

All indicators of "crime generator" and "crime enabler" were included in a GSV data collection tool created using Microsoft Excel. Each item was measured as a dichotomous variable (with "yes" meaning that an observed item was clearly captured by GSV; "no" meaning that an item was not identified via GSV).

Table 1: Classification of Environmental Mechanisms of Drug-Dealing Hot Spots

Environmental Mechanisms	Crime Generators	Items/Indicators	
		Universally conceptualized (easily identifiable by observers)	**Specific to the city center of Belo Horizonte**
Built structures	Recreational	Bars Restaurants/fast food establishments Parks	"Nightclubs" Movie theaters Musical theaters
	Retail	Liquor stores Commercial stores Convenience stores Shopping malls	"Liquor stores" Lottery tickets stores Motels for prostitution
	Residential	Homeless shelters Residential buildings	
	Educational		Colleges/Universities High schools
	Other	Churches	
Mobility Mechanisms	Transport	Public transportation hubs	MOVE Bus Rapid Transit Stations
	Passageways	Major thoroughfares Parking lots	"Regulated paid parking lots" (street/garage)
Hidden Mechanisms	Crime Enablers	Items/Indicators	
		Abandoned vacant lands Abandoned buildings	Locations near favelas Locations near other poor neighborhoods Locations where non-licensed street vendors congregate Trash collecting points Dead-end streets Locations near graffiti-ridden buildings Locations near walls with murals Locations near pedestrian ramps Locations near highway ramps

IDENTIFYING DRUG DEALING HOT SPOTS IN THE CITY CENTER

Previous research shows that street dealing of illicit drugs tends to be highly concentrated at specific places well-known by dealers and buyers for their low risk of apprehension (Kleiman 1991; Rengert 1996). Drug activity, as any other crime, varies across "micro places" such as street segments, street blocks, and other locations where there is a concentration of mechanisms producing criminal opportunities (Hsu and Miller 2017). With this in mind, this study uses street segments, which are defined as two streets facing each other between two intersections (Weisburd, Bushway, and Lum 2004), as its main unit of analysis. According to Weisburd *et al*. (2004), the use of street segments as the main unit of analysis provides the ability to understand and explain, at the street-level, the differences in the distribution of social disorganization mechanisms and physical disorder which help to influence the distribution of crime throughout space.

In order to select a sub-set of street segments with a high concentration of drug dealing in the downtown area of Belo Horizonte, we gathered data from drug-arrest data provided by the Military Police of the State of Minas Gerais. The arrest data includes 3,902 drug arrests related to the selling of cocaine, marijuana, and crack cocaine that occurred in the city center of Belo Horizonte for the period between 2007 and 2011. The use of arrests as a measure of drug markets has raised validity issues for the study, as drug arrests might only be an indicator of the reaction of police officers to pursuing well-known offenders (Eck, 1994; Ousey and Lee 2002), and may not be an indicator of how active and persistent a drug market can be at a specific location. However, drug arrests continue to be used as a main measure to identify street drug markets (Lipton, Yang, Braga, Goldstick, Newton, and Rura 2013). In order to identify stable hot spots of drug dealing during the period in question and thereby avoid places where drug-dealing has occurred by chance, it was decided that only addresses where at least five drug arrests had occurred for each year in the study (2007, 2008, 2009, 2010, and 2011) would be included in the analysis. This was based on the same criteria used by Hsu and Miller (2017) in studying the hot spots of drug markets in Newark. As a result, 135 street segments (or 28 percent) out of a total of 471 street segments in the downtown area and with a minimum of five arrests were selected to represent drug dealing hot spots. This total of 135 street segments is considered a reasonable number for proceeding with GSV observations and statistical analysis.

RECRUITING PARTICIPANTS

Initially, a total of six observers were recruited to participate in this project. The criteria predicated a diverse group of multiple observers, some native and residents of Belo Horizonte, and others native and residents in the U.S. If raters of diverse culture could agree on the environmental mechanisms observed on GSV, it would imply that GSV imagining of the mechanisms is a stable and reliable tool among future users.

The observers were divided into two groups. One was comprised of two female Brazilian undergraduate students and the other group was formed by three male and one female American students. The Brazilian students are majors in Sociology, and the American students are majors in Criminal Justice. While there is no Criminal Justice filed in Brazil, Sociology may be considered equivalent. Two of the America students volunteered to participate in this project with the leading author, but one dropped out, and the two other American students were summer interns paid by the second author. The Brazilian students were paid via a partnership with the leading author and the Center of Studies on Crime and Public Safety Policies (CRISP) at the Federal University in Belo Horizonte.

Training sessions were provided for the student observers during early summer 2016. Each observer individually and separately completed five sets of a GSV-based observation instrument containing a set of environmental auditing questions. Using GSV, the raters walked through five identified street blocks in Newark, NJ, where the authors were located at which the time of the project. These locations were known by the police for drug activities (the observers were unware of it to avoid any bias), and were also locations at which the second author had made an in-person observation previously. Each rater used an auditing instrument to tally the amount of specified items they observed on GSV. The table below shows the recruiters' main characteristics.

The training provided recruiters with the same level of knowledge regarding how to use GSV and how to conduct online observation using the audit. The training guidelines as well as the online audit used in this research was translated into Portuguese for the Brazilian recruiters. Within two weeks, the submitted

Table 2: Main Observers' Features

Features	Observers				
	A	B	C	D	E
Nationality	Brazilian	Brazilian	American	American	American
Location	Belo Horizonte	Belo Horizonte	Pennsylvania	Pennsylvania	Long Island, NY
Method of recruitment	Paid intern	Paid intern	Paid intern	Paid intern	Volunteer
Gender	Female	Female	Male	Female	Male
Education background	College sophomore Sociology	College sophomore Sociology	College sophomore Criminal Justice/Computer Science	College junior Criminal Justice	College senior Criminal Justice
Familiarity with Brazil or Belo Horizonte	Very familiar	Very familiar	None	None	None
Time Taken	2016.06 – 2016.10	2016.06 – 2016. 10	2016.06 – 2016.08	2016.06 – 2016.08	2016.06 – 2016. 09

outcomes of these five sets of observation from the five raters appeared to indicate a high of agreement.

ASSESSING RELIABILITY OF GSV: METHODOLOGY

This study employs an intra-class correlation coefficient (ICC) index as a measure of reliability. This index allows the comparison between similarities and differences among scores observed by multiple raters, who coded a sample of 135 street segments of drug-dealing hot spots by using the GSV data collection instrument. To avoid bias on coding, raters were not aware that the observed street segments were locations of active drug dealing.

Reliability refers to "the extent to which measurements can be replicated" (Koo and Li 2016:155) and the ICC is considered the most respected reliable index as it reflects both the degree of correlations as well as agreement between measurements (Koo and Li 2016). A Two-Way Mixed-Effects Model to approximate the ICC results was used in this paper since the main goal here is to compare observations from multiple recruited raters and have each item assessed independently by each rater. Absolute agreement among scores was examined in order to detect actual differences in any score presented by each rater. "The value of the ICC ranges from 0 to 1, where if, as the ICC approaches 1, then there is a perfect agreement between the raters, and as the ICC approaches 0 there is no agreement between the raters" (Hsu 2014:109). The ICC values are classified according to Landis and Koch (1977) as follows:

- values between 0.0 and 0.2 indicate slight agreement,
- values between 0.21 to 0.40 indicate fair agreement,
- values between 0.41 to 0.60 indicate moderate agreement,
- values between 0.61 to 0.80 indicate substantial agreement, and
- values between and 0.81 to 1.0 indicate almost perfect or perfect agreement.

The intra-class correlation coefficients (ICC) and their 95% confidence interval, used to assess the reliability of coded measures on the GSV observational tool, were calculated using the SPSS statistical package.

FINDINGS AND DISCUSSION

Findings were mixed with inter-rater agreement scores of the coded items ranging from "almost perfect (or perfect)" to "fair". Table **3** shows that out of the total of 40 coded items, nine of them yield "perfect" (or "almost perfect") agreement among the raters. Four of these nine items are related to retail establishments, two are transport-related items, and two are recreational items. All of them fall under the category of crime generators. In particular, raters had almost perfect agreement across all the gas stations with convenience stores (ICC = 0.924) and newspaper stands (ICC = 0.901) that they observed. Overall, these

Table 3: Items with Almost Perfect or Perfect Score of Inter-Rater Agreements According to ICC*

Environment mechanism/type of place	Item	ICC	95% CI	*p-value*
Built structure/crime generator	Gas station w/convenience store (retail)	0.924	(0.899-0.945)	0.000
Built structure/crime generator	Newspaper stand (retail)	0.901	(0.868-0.928)	0.000
Built structure/crime generator	Bank (retail)	0.890	(0.852-0.920)	0.000
Mobility Mechanism/crime generator	Bus stop (transport)	0.886	(0.847-0.917)	0.000
Built structure/crime generator	Church	0.847	(0.832-0.908)	0.000
Built structure/crime generator	Retail store	0.863	(0.817-0.900)	0.000
Built structure/crime generator	Hotel (residential)	0.856	(0.805-0.897)	0.000
Mobility Mechanism/crime generator	MOVE RBT station (transport)	0.824	(0.765-0.871)	0.000
Built structure/crime generator	Park/Square (recreational)	0.824	(0.763-0.872)	0.000

*Two-Way Mixed-Effects Model.
Almost Perfect or Perfect Agreement score: ICC between 0.81 and 1.0.

items are examples of built and mobility mechanisms that are easily identified with precise definitions and consistent perception across raters, as was expected by our first hypothesis.

The results also show that the ICC score of inter-rater agreement varied between "substantial" (12 out of 20) and "moderate" (8 out of 20) for half of items (20 out of a total of 40). Among twenty items with "substantial" or "moderate" scores, the majority of them (12 out of 20) were related to the "built structures," particularly under "retail" category. The remaining were related to "hidden spaces" and "mobility mechanisms" (See Table **1A** and **2A**, appendix 1). These items, like those with a "perfect" score are universally recognized for what they are.

Therefore, it was expected that these items would have scored "Perfect" as we had hypothesized, instead only "substantial" or "moderate." For example, it was expected that recreational related-items, such as restaurants and bars, would score "perfect," instead of "substantial," but they did not; outside observers not familiar with the dynamics of a street segment and activities could not easily distinguish bars from restaurants/fast food eateries.

Other items that we hypothesized would be scored "fair" or "poor" such as motels for prostitution, stores selling lottery tickets, and locations for non-licensed street vendors were scored with substantial inter-rater agreement among raters. These items have specific features that are particular to the context of the downtown area of Belo Horizonte, which would make it difficult for outsider observers using GSV to code them.

It was hypothesized that motels (which are often unmarked, used exclusively by pimps, prostitutes, and their Johns) would not be easily identified by GSV, unless it was a native observer familiar with the locale. However, this "substantial score" has to be taken with caution, as raters might have to trigger other types of signs and images. These would include deteriorated buildings located near bars in filthy streets, which are typical signs of prostitution zones elsewhere, to identify motels which are being used for the practice of prostitution only, as occurs in Belo Horizonte.

Similarly, another item that was expected to have a "fair" (or "poor) agreement score was specialty stores only selling lottery tickets; this item instead received a "substantial" score agreement. An English-speaking observer could easily identify the store by its outside sign saying "lottery," since the word is not translated into Portuguese and appears to be international.

Additionally, non-licensed vendors scored "substantial", instead of "fair" (or "poor") as was expected. Non-licensed vendors are not usually located at fixed spots, and are under constant surveillance by the police and city administration to aid in controlling the urban environment.

Furthermore, the results show that seven items experienced "fair" agreement between the raters. Four of these items are hidden spaces-related items, two are built structures-related items, and one is a mobility

Table 4: Items with Fair Score of Inter-rater Agreements according to ICC*

Environmental Mechanisms/type of place	Item	ICC	95% CI	*p*-value
Mobility mechanisms/crime generator	Regulated parking lot on street (public way)	0.365	(0.157-0.535)	0.001
Hidden Spaces/crime enabler	Near favelas	0.361	(0.128-0.542)	0.002
Hidden Spaces/crime enabler	Abandoned buildings	0.359	(0.156-0.526)	0.000
Built Structures/crime generator	Colleges/Universities (education)	0.337	(0.117-0.516)	0.002
Hidden Spaces/crime enabler	Near poor neighborhoods	0.332	(0.133-0.502)	0.001
Hidden Spaces/crime enabler	Near to pedestrian ramps	0.298	(0.078-0.481)	0.005
Built structures/crime generator	Liquor store (retail)	0.241	(-0.050-0.424)	0.053

*Two-Way Mixed Effects Model.
Fair Agreement score: ICC between 0.21 and 0.40.

mechanisms-related item, as shown on the table above:

Raters tend to disagree on what they perceived as a public way. It is likely the signs of regulated pay parking spots are not easily identified (ICC = 0.365). Also, it is possible that when an observational item is "subjective" or "cultural," such as whether a location is near favelas (ICC = 0.361), near a poor neighborhood (ICC = 0.332) or next to a pedestrian ramp (ICC = 0.298), those items are likely to be subject to the observer's biased interpretation. Favelas do not have a complete list of addresses and therefore are not completely visible to the Google Street View. In addition, locations near poor neighborhoods were not easy identified by outside observers unfamiliar with the area. Additionally, abandoned buildings that received a "fair" score (ICC=0.359) of inter-agreement between raters fall into a gray area, since they are easily confused with other functioning run-down buildings and it is impossible to differentiate between them. This is very common in certain parts of the downtown area, especially in the bohemian zone where prostitution is popular. The absence of any indicators denoting or designating that a building is closed or uninhabited further confuses the issue. Additionally, the "fair" score of inter-rater agreement for educational institutions (ICC = 0.337), such as colleges and universities, might be explained by the fact that they are located in an open campus setting. Due to this fact, they are difficult to identify individually. As a result, outside observers might be unable to locate these educational facilities with ease.

Environmental features that are not part of the local culture of downtown streets, such as liquor stores, also had a "fair" score. Raters had very low agreement regarding the amount of liquor stores they observed (ICC = 0.211). We suspect that these liquor stores have indistinct and vague storefront signs which may not be easily located on Google Street View imaging. Yet, as previously mentioned, liquor is usually sold in supermarkets, *botecos* (small bars), and restaurants.

In particular, the trash collecting point (ICC = -0.008), night club / disco (ICC = -0.032), and the location that was physically close to a major thoroughfare (ICC = -0.210) experienced negative ICC statistics, indicating that the raters seemingly had very different concepts or understandings about these items. These negative scores should be interpreted within the cultural context of Belo Horizonte. For instance, trash collecting points are part of a recycling cooperative of homeless people who collect paper and cardboard. These points could be misinterpreted as areas where the homeless congregate without specifically describing what is actually happening there. Night clubs which function in the bohemian zone of the downtown area also reduce the reliability of GSV, as was expected. This could be explained by the fact that they are often located on the second floor of a building and frequently unmarked.

CONCLUSION

Although the data is related to a four-year period, the GSV, implemented in Brazil in 2010, provides images that will not allow for a retrospective analysis of changes and how these changes of environmental features over a period of time might have impacted locations of street drug dealings. Consequently, the results in this study are susceptible to informational bias and any conclusion made regarding the relationship between features of places and location of street drug dealing should be taken with caution.

Overall, the findings support all three hypotheses. Familiarity with the streets by an outsider observer

seems relevant to improving the reliability of GSV in the context of certain activities, such as prostitution zones and recreational areas. This can vary from country to country. Items that are universally conceptualized (i.e., built structures and mobility mechanisms) received a higher level of inter-rater agreement among raters than items specific to downtown Belo Horizonte (i.e., locations near favelas and "liquor stores"). However, our findings have to be taken with caution. The results also suggest that the reliability of GSV used in international research is challenged by other factors that are not related to our hypotheses. These factors are: visibility and the need for better images.

Visibility

The first factor, visibility, refers to the lack of sufficient outdoor signs and markings that allow the identification of main features in environments related to retail, recreational, education, as well as hidden places. In this case, the reliability of GSV depends on external resources such as local place managers and owners of buildings responsible for improving the visibility of their properties. The city government also needs to upgrade its regulations requirements in order to more easily identify features that characterize the environment of the downtown area, as well as revamp the addresses of parts of the city where an address seems to be non-existent, such as is often the case in favelas.

Need for Better Images

A fundamental challenge faced by any researcher using a secondary source of data is the fact that the data was collected for a different purpose, and this holds true for using GSV. The images captured might not be taken from an angle that would better represent the item or feature that is important for a specific researcher. In this current study, the fact that features of some streets were not clearly visible due to various obstacles was crucial, since detailed features are relevant to the main assumption that the environment creates opportunities for drug dealing. GSV is used to facilitate the imaging of streets, but due to its limitations, it cannot be the sole arbiter in achieving the research results required.

Research findings suggest that Google Street View is a useful, but incomplete tool, particularly with regards to the immediate environmental features that are subjected to the local culture and streets dynamics. It is important to highlight physical obstacles and the inexistence of some addresses, which also decrease the reliability of the instrument. We need a combination of tools and strategies to make the data collection process truly reliable.

Reliability issues related to the use of GSV in collecting data abroad can be summarized by the narrative provided by one of the outside raters in this project, below:

> Doing the Google Street View project was a difficult task. I have never been to Brazil before and don't speak the language. The use of Google Maps and the Street View were amazing in seeing things that you would not be able to see otherwise. If given the opportunity, I would have rather collected the data in the field, because I feel it would have been easier to see everything, and you would actually be in the location, experiencing it as well. On Google Street View, many times there are obstructions that make observation difficult, such as a bus in the lane next to you, which ends up blocking a huge view. Also, some of the streets were not recognized by Google Maps, and were inaccessible from the Street View. This created an issue because you can't simply walk around; the observer can only see what is visible from the Google Street View application. Also, many times, it was difficult to decipher bars from restaurants, which establishment were selling lotto tickets, which graffiti was legal, what is considered a poor neighborhood, the location of favelas, and other slight implications. If I were to be more familiar with the area, it would certainly be easier. That being said, I do believe that it incorporates another aspect of research, having an unbiased outsider participate in the research, rather than a local familiar with the area.

Another rater, a native from Belo Horizonte, indicates GSV reliability issues due to the existence of physical obstacles, as previously described:

> In places where there were Rapid Transit Bus stations, it was not possible to observe both sides of the street in a single route. I also noticed a difficulty in seeing

the higher buildings, which are not at street level. The view of the upper floors is not as good as for the first floor, making it difficult to see the plaques and other signs affixed to the buildings.

In order to overcome some of the issues related to the reliability of the GSV as previously discussed, this research suggests that researchers employing GSV in international research should have the collaboration of local researchers. It would be also helpful to have a local informant or research assistant to conduct direct field observations, video-taping or photographing locations when possible where the GSV image is impaired by obstacles such as vegetation or a high volume of pedestrians or vehicles, particularly large trucks. Criminologists have entered a new age of conducting research abroad when universities have been promoting assistance and funding for collaborative international research in many different ways. The use of GSV would have a collateral impact on international research, as it encourages collaborative research with local scholars. This now appears to be the norm and certainly helps to facilitate the required work with virtual success.

ACKNOWLEDGEMENTS

We would like to appreciate and thank the Military Police in the State of Minas Gerais for providing the data, Colonel Daniel Garcia and Professor Braulio F. Silva for their support and comments, as well as all the students from Brazil and the U.S. who participated in the data collection process using Google Street View. We also thank the Kutztown University of Pennsylvania and the Center of Research on Crime and Public Security – CRISP at the Federal University in Belo Horizonte which assured internal grants for students' participation in this research.

APPENDIX

Table 1A: Items with Substantial Score of Inter-Rater Agreements According to ICC*

Risk Factor/Category	Item	ICC	95% CI	*p*-value
Built structure/Retail	Motel (prostitution)	0.803	(0.737-0.857)	0.000
Built structure/Recreational	Bar/Tavern	0.785	(0.713-0843)	0.000
Built structure/Retail	Shopping mall	0.782	(0.710-0.841)	0.000
Built structure/Retail	Barber and Beauty shop	0.771	(0.685-0.837)	0.000
Hidden structures	Mural/legal graffiti on building walls	0.762	(0.683-0.827)	0.000
Built structure/Recreational	Restaurant/Fast food eateries	0.749	(0.659-0.819)	0.000
Built structure/Recreational	Movie theater	0.748	(0.663-0.816)	0.000
Built structure/Retail	Street vendor	0.745	(0.660-0.814)	0.000
Hidden structures	Graffiti	0.733	(0.643-0.806)	0.000
Built structure/Retail	Store selling lottery tickets	0.720	(0.612-0.802)	0.000
Mobility Mechanisms/Public ways	Parking spots on street/garage	0.713	(0.615-0.791)	0.000
Built structure/Recreational	Musical theater	0.605	(0.466-0.714)	0.000

*Two-Way Mixed-Effects Model.
Substantial Agreement score: ICC between 0.61 and 0.80.

Table 2A: Items with Moderate Score of Inter-Rater Agreements According to ICC*

Risk Factor/Category	Item	ICC	95% CI	*p-value*
Mobility mechanisms/Transport	Train station	0.590	(0.434-0.708)	0.000
Built structure/Education	High school	0.552	(0.398-0.675)	0.000
Hidden spaces	Dead-end street	0.551	(0.404-0.671)	0.000
Hidden spaces	Next to highway ramp	0.524	(0.344-0.661)	0.000
Built structure/Residential	Homeless shelter	0.430	(0.241-0.583)	0.000

Mobility mechanism/Transport	Transportation hub	0.419	(0.236-0.572)	0.000
Hidden spaces	Abandoned vacant land	0.417	(0.226-0.574)	0.000
Built structure/Residential	Homes and Apartment building	0.407	(0.220-0.562)	0.000

*Two-Way Mixed-Effects Model.
Moderate Agreement score: ICC between 0.41 and 0.60.

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Received on 19-10-2017 Accepted on 02-01-2018 Published on 02-02-2018

DOI: https://doi.org/10.6000/1929-4409.2018.07.04