

Clandestine Dumpsites and Crime in Mexico City: Revisiting the Broken Windows Theory

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Abstract

This paper revisits the broken windows theory with a particular focus on one sign of social disorder: clandestine dumpsites. To explore whether these are predictors of different types of crimes at a neighborhood level, two classification methods were used. Results suggest that clandestine dumpsites have a high predictive capacity for the crimes of dispossession, property damage, house robbery, vehicle theft, and robbery, and have almost none for environmental crimes or robberies of businesses. It is suggested that clandestine dumpsites should be the object of a comprehensive public policy that, in addition to reducing or eliminating the associated health and environmental risks, seeks to reconstitute the social fabric and motivates the long-term recovery of the public space.

Keywords

broken windows, clandestine dumpsite, classification methods, Mexico City

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Introduction

According to the traditional understanding of the broken windows theory (BWT hereafter), minor forms of public disorder (generally administrative offenses) can lead to more serious forms of crime (Wilson & Kelling, 1982). In other words, actions such as vandalism, the accumulation of trash in a corner or in vacant lots, graffiti, or the consumption of alcohol in the street, trigger a perception of physical disorder that leads to an increased fear of crime (with an increased tendency for inhabitants to remain indoors) and a lack of neighborhood social organization (Sampson & Raudenbush, 2004; Steenbeek & Hipp, 2011).

Visual signs of disorder in public spaces become crime attractors as they transmit the impression of a certain indifference (or inability to control) of the population regarding what occurs in their community. People retreat from the streets (that begin to be seen as dangerous), and this increases a neighborhood's vulnerability to crime. As observed by Gault and Silver (2008), "The lack of ordinary people going about their activities signals that deviant behavior is tolerated in public locations" (p. 3). That is, it suggests that no-one cares about the neighborhood and thus will not do anything (react or call the police) in the event that a greater crime occurs (Kelling & Coles, 1997). This idea has been extremely influential in criminology in recent years, and particularly for public policy design and implementation (Harcourt, 2005; Taylor, 2018).

However, beyond this, the general, classic question of whether disorder does or does not cause crime (Sampson & Raudenbush, 2004) is still valid, particularly if some of the elements of this disorder are associated with the commission of crimes. The importance of public disorder as a crime attractor has led most studies to focus on disorder in a general way, as a set of attractors, without studying each sign of disorder individually (although there are exceptions, such as Krimmel and Mele's (1998) study of car junkyards).

In this regard, clandestine dumpsites are an important element of social disorder and while they have been the object of study of various disciplines, they have received little specific attention in the criminological literature. In general, clandestine dumpsites can be defined as not formally authorized spaces (typically streets, vacant lots, parks, and other common areas) where private citizens and businesses dispose of waste, such as construction and demolition materials, auto parts, tires, electrical appliances, domestic waste, garden waste, furniture, and/or biomedical waste. In practice, they may be understood as spaces to which the community has assigned a lower social value and as such, are objects of neglect and deterioration. A perception of limited care and disinterest by the community may be linked to disorder

(Franzini et al., 2008) and inaction by the police in terms of avoiding and sanctioning deviant behavior in such spaces (Kelling & Coles, 1997).

Clandestine dumpsites have generally been studied in relation to environmental crimes (Brickey, 2001; Lambrechts & Hector, 2016), propagation of illnesses, economic risks related with devaluation of property (Critto et al., 2003; Giovannini et al., 2014), and in terms of community safety (Matos et al., 2012). However, this has been limited, and they are generally dealt with as a specific point of physical disorder related to the broken windows theory (Brandt, 2017). The situation is similar in the case of studies in Latin America: most work focusses on waste pickers, epidemiological risks (Cruvinel et al., 2019), gender-related response to environmental degradation (Paolisso & Gammage, 1996), collective actions (Roberts & Portes, 2006) and urban developments (Borsdorf et al., 2007). No studies consider clandestine dumpsites as specific points of reference of social disorder.

Within this context, this work explores whether clandestine dumpsites are predictors of different types of crime, using two classification methods: step-wise logistic regression models and a naïve Bayes classifier. Following the BWT, we hypothesize that clandestine dumpsites can be a predictor of property related crimes and robbery but have little to no predictive capacity for individual targeted crimes. We argue that identifying clandestine dumpsites as predictors of certain crimes is crucial for public policy, as not only do they pose a risk to the economy (Ogunrinola & Adepegba, 2012), to public health (Tongesayi et al., 2018), and to the environment (Aja et al., 2021), but also to public safety. That is, clandestine dumpsites should be the motive of a comprehensive policy that highlights the risks already mentioned and aims to reconstitute the social fabric and thereby facilitate the long-term recovery of the public space.

Furthermore, this research seeks to fill a gap in the literature on BWT that has generally dealt with the issue of clandestine dumpsites as a problem within a set of public disorder signs (abandoned cars, graffiti, vandalism), but not as an individual predictor of certain crimes. This is probably due to the fact that the accumulation of trash on certain streets and corners in the large cities of developed countries, does not represent the magnitude and persistence of clandestine dumpsites that it does in cities of the developing world. The formation of clandestine dumpsites is not just an urban policy issue, but also one of social control, as the deterioration of a neighborhood is immediate, and the degradation of the environment impacts inhabitants' quality of life.

The remainder of this paper is structured as followed: section 2 summarizes the principles, advances, and conclusions of studies on BWT, while section 3 does so with an emphasis on the Latin American region. Section 4

describes the presence of clandestine dumpsites in Mexico City and their relevance to the configuration of the city. Section 5 describes the data and methods, while section 6 presents the main results and a discussion of their implication for security policies. Finally, section 7 presents concluding remarks.

Revisiting Broken Windows Theory

The novelty of BWT is the emphasis it places on the physical and material environment of a community and the impact of this on human behavior (in comparison with traditional perspectives on social identity, social inequality, and peer culture). The theory maintains that the presence of physical disorder (even something minor) creates a perception of a degree of social permissiveness regarding both physical and social disorder. That is, a physically disordered social environment normalizes and even promotes new social and physical disorders. In contrast, a physical environment that is well cared-for fosters social order. Physical order and social order go hand-in-hand, encouraging or discouraging opportunities for people to commit crime (Wilson & Kelling, 1982).

The BWT refers to disorder as a predictor of crime through a model of community decay that is based on the failure to prevent and correct social and physical incivilities (begging, vagrancy, trash, and graffiti). According to Gault and Silver (2008), the literature on BWT developed in regard to three broad areas: (a) public disorder and fear of crime, (b) fear of crime and reduced social control, and (c) social control (collective efficacy) and crime.

Regarding the first, the idea that physical disorder has a negative impact on the fear of crime, has been widely disseminated in criminology since approximately 1990 (Perkins et al., 1996; Ross & Mirowsky, 1999). It suggests that incivility and visual signs of disorder increase fear of crime, independently of real victimization (Markowitz et al., 2001). Subsequently, various authors have sought to provide empirical support for the association between disorder and fear (Robinson et al., 2003; Wyant, 2008).

The vast majority of studies have been based on transversal data that hinder the determination of how exactly fear causes a (greater) perception of physical disorder, or on the contrary, how disorder provokes fear, or whether both are determined by a third factor that generates both fear and disorder (Robinson et al., 2003). In this regard, those studies focused on more objective measurements of disorder, rather than on the measurement of individual perception of fear and perception of disorder, have, paradoxically, found a less solid link between the two variables (Brunton-Smith & Sturgis, 2011; Sampson, 2009; Taylor, 2018).

Currently, the literature has developed an interest in the contingent nature of perceptions of disorder, and its individual interpretation as a local issue by residents of a community (Spelman, 2004). That is, visual signs may be ambiguous, and this can cause wide variability in residents' individual perceptions of their local environment. In other words, not only is the objective incidence of disorder within a local area the focus of study, but also the wide range of drivers of individual perceptions (Franzini et al., 2008; Twigg et al., 2010).

In this regard, individual stereotypes are contingent and may play a role in this perception (Sampson & Raudenbush, 2004), despite not being directly related to disorder. This has led various authors to incorporate a more socio-psychological analysis when exploring the influence of social attitudes on vulnerability, how disorder is interpreted, and the consequent fear of crime. For example, Jackson and Gray (2010) consider that fear of crime itself may, in turn, be another driver of perceived disorder, increasing residents' awareness and the probability of a negative perception by these individuals regarding the physical disorder on a neighborhood level.

In response, Brunton-Smith and Sturgis (2011) argue that the relation between fear and perception of disorder may be co-determined by non-observed variables. This means that the relationship between physical disorder and fear of crime may be a product of the measurement instruments that align perceptions of disorder and fear of crime in the evaluation itself. That is, disorder and fear are mutually coterminous (Farrall et al., 2009).

Regarding fear of crime and the reduction of social control, the BWT is discussed with the assumption of a relationship between fear of crime and less social control. That is, an increase in the fear of crime (resulting from physical disorder) is assumed to cause inhabitants to retreat from the streets, which in turn, reduces informal social control. Residents' concerns regarding their neighborhood, manifested as fear, negatively affects collective efficacy and territoriality (Pitner et al., 2012). This model was initially tested by Skogan and Maxfield (1981) who found that disorder has a significant positive effect on fear, while cohesion had a significant negative effect on fear.

However, other authors have found a "delay" in the effect of perceived incivilities on the increase in perception of vulnerability and fear of crime, and a decrease in general levels of satisfaction of a neighborhood (Robinson et al., 2003). Residents of a neighborhood avoid public areas, begin to spend more time inside their homes, and reduce contact with their community. In this regard, according to some authors, perception is as important as fact, and perceived incivilities are a positive and consistently significant predictor of fear of crime (Wyant, 2008). In other words, the perception of physical disorder, along with its severity, is a stronger predictor of fear of crime than real

disorder. This vicious circle necessarily leads to the erosion of informal social control and community vigilance (Gault & Silver, 2008). This relation is common in studies focusing on urban areas (Scarborough et al., 2010), as well as in work that look at relatively rural or barely urbanized areas (Reisig & Cancino, 2004).

Nevertheless, the association between fear of crime and decreased social control has received certain criticism. For example, Robinson et al. (2003) suggest that the relationship is circular, that is, that fear of crime also determines the perception of physical disorder. Beyond this, the study of this association has two difficulties: (a) the non-observable individual characteristics of residents of a neighborhood (Harcourt & Ludwig, 2006), and (b) the visual characteristics of neighborhoods and their consequences (Skogan, 1990).

Finally, the central argument of social control and criminality revolves around the association between collective efficacy and crime (Wikström & Dolmén, 2001). It proposes that residents protect their community through their participation in the informal control of the security of their neighborhood in two ways: by directly intervening in problems (e.g., by controlling antisocial behaviors, notifying other neighbors), or indirectly by appealing to the police or for the intervention of a State agency (Warner, 2007). That is, a form of community and social management of security is evident. Within this context, the work of St. Jean (2008) is crucial as it examines whether the theories of broken windows or collective efficacy can explain the concentration of crime in certain districts of Chicago.

Simply put, collective efficacy is nothing more than neighbors controlling deviation from the norm in their community. Based on this, the BWT maintains that, should physical disorder increase, so too will residents' fear, thus resulting in their retreat from public life. This retreat implies less informal social control and greater crime opportunities (Sampson, 2004). Public disorder is a sign that may motivate the commission of more serious crimes and, in turn, a decrease in the social control of crime.

Within this context, there are numerous studies that focus on signs of public disorder. However, disorder is always understood as a set of signs, for example, abandoned vehicles and graffiti, among others. Practically no work exists that considers clandestine dumpsites as specific signs of disorder. In areas of clandestine dumpsites, social disorganization decreases the capacity of residents to exercise social control and reduce both crime and violence. The consequences of the fear of crime are a loss of trust and a drop in community social cohesion and integration. The loss of trust is a particularly serious problem in Mexico, and has a direct impact on public safety, that ranges from crime reporting (Heredia-González et al., 2022) to police corruption (C. Vilalta & Fondevila, 2020).

In reality, collective efficacy is a continuous process at the neighborhood level, that operates as a mechanism of intermediation between the community and disorder, independently of socio-demographic variables. Even neighborhoods with unfavorable economic conditions can experience high levels of social cohesion, and consequently, of collective efficacy in crime control (Morenoff et al., 2001). In such areas, community networks function as protection against crime and disorder by promoting integrated community values (Rader et al., 2012). This not only refers to the control of incivilities in the neighborhood and surrounding environment, but on the contrary, such networks also function as mechanisms of individual protection of young people in the community against serious violence, and medical emergencies, among others. At the same time, they are mechanisms of mediation with the State, through the police, social security institutions, and public health.

In other words, social disorder plays the same role for both collective efficacy and for BWT: high levels of collective efficacy (few signs of social disorder) are predictors of low crime, while alternatively, low collective efficacy (many signs of social disorder), predicts high crime levels. Given this, St. Jean (2008) proposes the notion of “ecological disadvantage,” arguing that some places are more attractive to certain types of crime due to the particular modus operandi of the crime, independently, or collaterally of social disorder/order. He suggests that something about the geographical point determines its relevance for the ideal functioning of a criminal activity. This ecological disadvantage should be added to any analysis of social disorder in terms of collective efficacy. In other words, social disorder is an important predictor that should be complemented with the analysis of the modus operandi of the crime under study.

Broken Windows Theory in Latin America

The BWT has been widely received in the Latin American region, particularly on a policing level. This is reflected in the Latin American literature on the issue, that has concentrated on the effects of zero tolerance policies linked to BWT on security agendas, as well as the effectiveness of BWT-related policies on crime reduction.

Regarding the first, most studies focus on the increase in punitiveness in relation to zero tolerance policies derived from BWT. For example, Müller (2012) identified this policy as the driver of the rise of the penal state and a central characteristic of the global expansion of neo-liberalism and the urban marginality of government. Other studies look at the context of zero tolerance and BWT as the foundation for “heavy handed” security policies. Dammert and Malone (2006) showed that economic, political, and social insecurity are

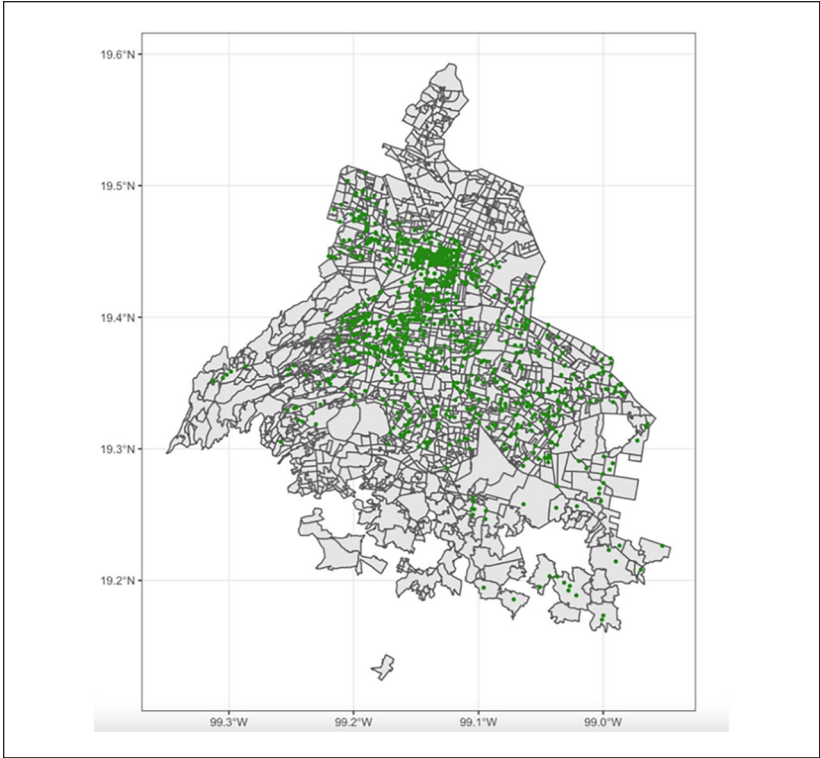
the main determinants of citizens' fear of crime. Davis (2013) studied the limitation on public access to spaces in the center of the city, while Glebbeek (2010) focused on analyzing violence and insecurity in Central America and heavy-handed responses based on the zero-tolerance policy. Added to this, Swanson (2013) studied the punitive inequalities of the zero-tolerance policy in Latin American cities and its consequences for marginalized young people.

On the other hand, more recent studies have emerged that focus on the BWT from a crime reduction point of view. For example, C. J. Vilalta et al. (2020) studied homicide counts and census data at the neighborhood level in Mexico City and concluded that social and physical disorder cannot be considered separate elements that operate independently. The impact of social disorder decreases as neighborhoods become less physically disordered, and vice versa. In the Colombian case, Mejia et al. (2022) found that the direct effects of broken windows policing are immediate and precise in blocks with low criminality, but that beneficial indirect effects appear to be more important in crime hotspots. The effects of such policing appear to be limited to cities with low or moderate levels of organized crime, perhaps due to the planning of criminal organizations.

Disorder and Clandestine Dumpsites in Mexico City

In Mexico, the Ministry for the Environment (SEDEMA) defines a clandestine dumpsite as a space in which waste is illegally deposited on a regular basis, in large quantities, and collectively in quantities greater than 50 kg. They are generally detected by municipal workers during inspections of waste materials and tend to be found on public roads, containing a mixture of organic and non-organic waste as well as the incorrect management of bulky waste and waste from construction and demolition sites (Secretaría del Medio Ambiente de la Ciudad de México [SEDEMA], 2019).

Map 1 illustrates the presence of clandestine dumpsites in Mexico City in 2017. According to SEDEMA's (2019) Solid Waste Inventory, 1,229 dumpsites were identified in that year, 1,251 in 2018, and 984 in 2019, a decrease of 21.34%. In 2017 the following municipalities registered the highest number of clandestine dumpsites: Cuauhtemoc (278), Iztapalapa (249) and Benito Juárez (147), while those with the least irregular disposal were Cuajimalpa de Morelos (5), La Magdalena Contreras (5) and Xochimilco (12). It is worth noting, that in 2019, only 67 reports were made to the General Directorate for Environmental Inspection and Monitoring. That is, despite the persistent



Map 1. Location of clandestine dumpsites in Mexico City.
Source. Own elaboration with data from the Ministry for the Environment (SEDEMA).

nature of the problem, its resolution does not appear to have been a priority for either the municipality or inhabitants.

At the neighborhood level, the presence of clandestine dumpsites is somewhat similar. Table 1 shows a list of the 20 neighborhoods with the most clandestine dumpsites in 2017. A high concentration of clandestine dumpsites can be observed in the municipality of Cuauhtemoc, which incorporates 9 of the top 10 neighborhoods. It is noteworthy that the historical center of Mexico City, a space with dynamics and activities similar to that of the downtown of any major city across the world, is located within this municipality.

Another interesting characteristic is that recurrent clandestine dumpsites tend to be located on public roads that border two municipalities. This creates coordination issues as it may be unclear which of the two authorities should assume responsibility for dealing with it. There also appears to be a certain

Table 1. The 20 Neighborhoods With the Highest Number of Clandestine Dumpsites in Mexico City.

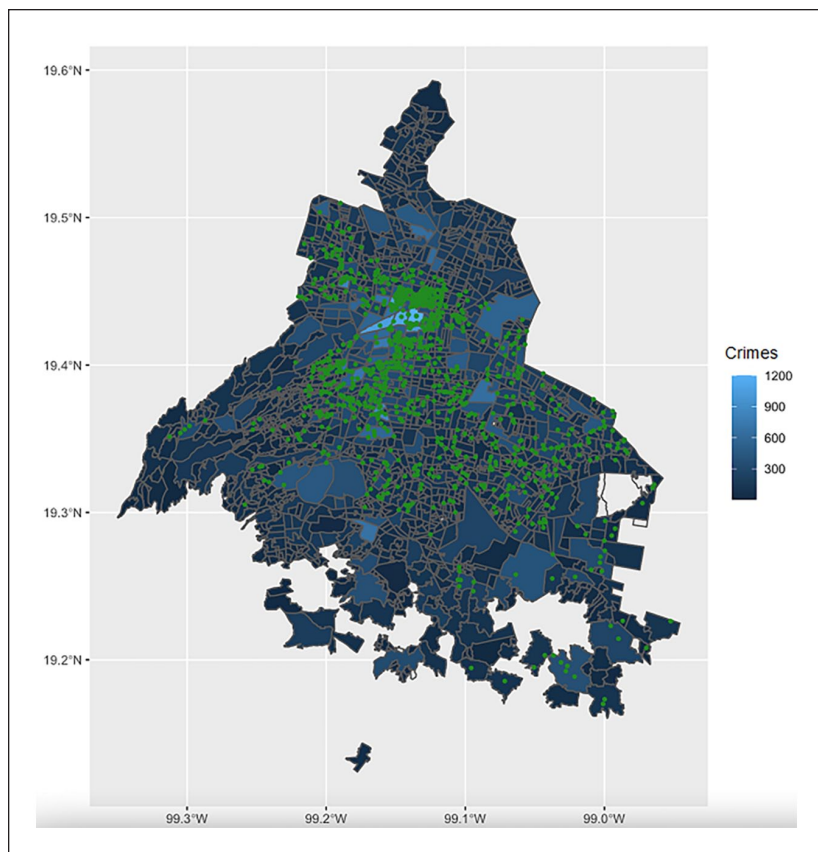
	Neighborhood	Municipality	No. of dumpsites
1	Morelos III	Cuauhtemoc	22
2	Centro I	Cuauhtemoc/ Venustiano Carranza	18
3	Buenavista II	Cuauhtemoc	16
4	Morelos I	Cuauhtemoc	15
5	Morelos II	Cuauhtemoc	15
6	Guerrero II	Cuauhtemoc	13
7	Guerrero I	Cuauhtemoc	12
8	Sta Cruz Atoyac	Benito Juarez	12
9	Buenavista I	Cuauhtemoc	11
10	Centro II	Cuauhtemoc/ Venustiano Carranza	11
11	Centro VIII	Cuauhtemoc	11
12	Moctezuma 2A Section III	Venustiano Carranza	11
13	Tacuba	Miguel Hidalgo	11
14	Atlampa	Cuauhtemoc	10
15	Del Valle IV	Benito Juarez	10
16	Narvarte II	Benito Juarez	10
17	Santiago Acahualtepec	Iztapalapa	10
18	Tacubaya	Miguel Hidalgo	10
19	Aplataco	Iztapalapa	9
20	Buenos Aires	Cuauhtemoc	9

Source. Own elaboration with data from the Ministry for the Environment (SEDEMA).

regularity to the social dynamic around clandestine dumpsites which varies according to the economic activity of the area (Sánchez, 2014).

A first step in analyzing the possible association between clandestine dumpsites and the commission of a crime is to observe its location and occurrence at a neighborhood level. Map 2 overlays the location of the clandestine dumpsites with the total number of reported crimes in each neighborhood in 2018. In general, it shows that in locations with a high number of clandestine dumpsites, reported crimes are also high. In this regard, it is noteworthy that the municipality of Cuauhtemoc also has the highest number of reported crimes.

Even though this initial analysis suggests an association between the presence of clandestine dumpsites and crime, a closer look that considers the



Map 2. Location of clandestine dumpsites and crime incidence by neighborhood in Mexico City.

Source. Own elaboration with data from the Ministry for the Environment (SEDEMA) and The Attorney General's Office of Mexico City (FGJ).

classical controls within the broken windows theory, must be implemented in order to explore the predictive capacity of the former over the latter. The empirical strategy used to do so is presented in the following section.

Data and Methodology

For the dependent variables, this study considers three types of crimes regarding land use: property related, robbery, and individual related. The objective of this distinction is to explore whether there is a differentiated importance of factors for the explanation of each type of crime. The first group considers

three crimes: dispossession, environmental damage, and property damage. The second group comprises four crimes: house robbery, business robbery, vehicle theft, and a general group encompassing all types of robbery to passers-by, denoted as robbery. The third group consists of four crimes: homicide, assault, rape, and domestic violence.

Information related to reported cases of the abovementioned crimes was obtained from files of the Mexico City Attorney General's Office (FGJCDMX according to its Spanish acronym) at the Mexico City Data Portal of the Mexico City Government Digital Agency for Public Innovation. We focused specifically on the number of investigation files that began in 2018 at a neighborhood level. This year was chosen given that data for our explanatory variable of interest, clandestine dumps, are only available (with the required characteristics for the study) until the end of 2017, and no variation data is publicly available before or after that. From this source, we obtained information about the type of crime, when it was committed (month, day, and hour), and where it was committed.

In order to explore our main hypothesis, the empirical strategy employs the number of clandestine dumpsites per neighborhood as the explanatory variable, controlling for crime attractors related to the BWT, and the 11 types of crime as dependent variables. We obtained data on the location of clandestine dumpsites from the Ministry of Environment (SEDEMA according to its Spanish acronym) through the Mexico City Data Portal of the Mexico City Government Digital Agency for Public Innovation. This dataset assigns a unique identificatory number for each clandestine dumpsite and where it is located. We matched the exact location of each clandestine dumpsite to the corresponding neighborhood and operationalized this variable as each neighborhood's total garbage dumps per km².

The first control variable considered for our analysis was land use. For this variable, seven levels were considered: residential, commercial, mixed (residential + commercial), green areas, industrial, neighborhood center, urban equipment, and offices. We obtained these data from the Secretary of Urban Development and Housing (SEDUVI according to its Spanish acronym). This dataset indicates all cadastral accounts in Mexico City, specifying the type of land use and its surface extension. As such, we were able to obtain the extension of land use in square meters on a street level. This variable was operationalized as a categorical variable indicating the predominant land use in each neighborhood.

In accordance with the BWT, we used a set of seven classic control variables that could be attractors or detractors of certain type of crimes at a neighborhood level (Demeau & Parent, 2018; Ejiogu, 2020; Houser et al., 2019; Kinney et al., 2008; McCord et al., 2007; Soto & Summers, 2020). The

neighborhood level control variables used were the number of public transport stops; public schools; convenience stores (including grocery stores and miscellaneous shops); restaurants; bars; banks; and pawn shops.

For the first two variables, we obtained data from: The Ministry of Mobility (SEMOVI) and the Ministry of Science, Technology, and Innovation (SECTEI according to its Spanish acronym), respectively. For the rest, the data came from the INEGI National Statistics Directory of Economic Units (DENUE according to its Spanish acronym). For all these variables, we used the geographic coordinates of their location (latitude and longitude) to calculate the total number for each neighborhood in Mexico City. Subsequently, we operationalized the variables as a total count per km² for each neighborhood. Finally, four additional controls related to crime commission were included: hour, day, and month of the crime, along with the municipality that corresponded to the neighborhood in which the crime was committed.

After cleaning the database and eliminating cases that lacked complete information, the final constructed database comprised 242,511 reported crimes, of which there was information for 13 independent variables (clandestine dumpsites as explanatory variables and 12 controls), with the type of crime as the explanatory variable. Table 2 summarizes the variables, their operationalization, and sources of information.

As the main goal of this study was to explore the predictive capacity of clandestine dumpsites for crime commission, tools were needed that estimate and rank this association. Our empirical strategy thus consisted of implementing two tools that explored the importance of the 13 variables for the classification of the crimes considered. The first was a stepwise logistic (logit) regression. In the simplest version of the logistic regression, it is a model of classification that consists of using information from the independent variables to model the probability of reaching a discrete binary outcome. Given its characteristics, it adapts easily to cases of more than two discrete outcomes. For the case considered in this study, we constructed a dichotomous variable for each type of crime, taking a value of 1 if the reported crime is of interest, and 0 in other cases. The output of this technique can be understood as the probability of being classified as a crime of interest, given the information of the characteristics of the reported crime.

As the precision and relevance of this type of estimation is sensitive to the selection of independent variables, a stepwise regression was conducted. This is a step-by-step iterative construction of a model that involves the selection, based on an information criterion (typically the Akaike information criterion—AIC), of the set of independent variables to be used in a final logistic model. Simply put, it includes or excludes potential explanatory variables based on a succession of model estimations along with the testing for

Table 2. Variables, Operationalization, and Sources of Information.

Type of variable	Variable	Operationalization	Source
Dependent	Type of crime committed	Dichotomous, one for each crime analyzed	Attorney General's Office in Mexico City (FGJ)
Explanatory	Clandestine dumpsites	Quantity per km ² , per neighborhood.	Ministry of Environment (SEDEMA)
Controls	Hour	Numerical value of time the crime occurred	Attorney General's Office in Mexico City (FGJ)
	Day	Numerical value of day the crime occurred	
	Month	Numerical value of month the crime occurred	
	Municipality	Categorical value of the place the crime occurred	Ministry of Urban Development and Housing (SEDUVI)
	Land use	Predominant land use in the neighborhood	
	Public transport stops	Quantity per km ² and per 10,000 inhabitants in the municipality	
	Public schools		
	Convenience stores		
	Bars		Ministry of Science, Technology, and Innovation (SECTEI)
	Restaurants		
	Banks		
	Pawn shops		

statistical significance of the estimators after each iteration. For this study we used the bidirectional stepwise logistic regression, that is, the comparison between the best model from the forward selection (starting from the most basic model and adding variables until the optimal is found) and the backward elimination (starting from the most complete model and eliminating variables until an optimal model is reached).

The second technique employed was the Naïve Bayes classifier. This is a supervised learning algorithm (based on Bayes theorem) used to determine the probability of a hypothesis (in this case that the reported crime is the one of interest) with prior knowledge of the manifestation of related random variables (in our case, the information regarding the 13 independent variables) in order to solve a classification problem. Given the construction of the dichotomous variable for each type of crime, we estimated a Bernoulli Naïve Bayes classifier for each.

The estimations of the 11 stepwise logistic regressions were conducted using the “step” function of the “stats” library of the R statistical environment, while the function “train” of the “caret” library was used for the estimation of the 11 Naïve Bayes classifier models. For the resulting 22 models, the importance of the variables within the estimation of each case was calculated through the “varImp” function of the “caret” “library” and ordered from largest to smallest to create a ranking of the relevance of factors in the crime classification.

Results and Discussion

The resulting estimators of the 11 stepwise logistic regressions are reported in Table 3. For this type of regressions, the independent variable and/or controls which were not found to be significant, were not kept in the final model, hence their effect is not included. The predictive capacity of the significant variables is measured by the absolute value of the reported Z-statistic. It can be observed that clandestine dumpsites have a significant predictive capacity in 9 of the 11 varieties of crime. They have virtually no predictive capacity for business robbery and rape.

When comparing the predictive capacity of independent variables and controls for each type of crime, a ranking of the absolute value of their estimated Z-statistics is needed, with the highest Z-statistics (in absolute terms) occupying the top position in terms of predictability compared with the rest of the independent variables and controls used in the model. For example, in the case of dispossession, the first four positions of this ranking were bank branches with a Z-statistic of approximately 10.88, bars with 5.99, land use with 5.31, and clandestine dumpsites with approximately 5.1. In order to facilitate this analysis, Table 4 shows the first four positions of the ranking obtained for the stepwise logistic regressions.

Models obtained with the Naïve Bayes classifier do not yield estimators comparable to those of the stepwise logistic regression. Simply put, they measure the number of times, from a specific number of samples considered, that the independent variables and controls were individually relevant, in

Table 3. Resulting Models: Stepwise Logistic regressions.

	Dispossession		Environmental crimes		Property damage	
	Z stat.	Pr(> z)	Z stat.	Pr(> z)	Z stat.	Pr(> z)
(Intercept)	40.415	0.000	***	0.000	***	0.000
Mayoralty	4.114	0.000	***	0.000	***	-
Land use	5.311	0.000	***	0.000	***	0.021
Clandestine dumps	5.120	0.000	***	0.007	**	0.000
Convenience stores	1.699	0.089	.	0.000	***	0.085
Bank branches	10.879	0.000	***	0.000	***	0.000
Bars	5.982	0.000	***	0.003	**	-
Restaurants	1.921	0.055	.	0.001	***	0.000
Pawn shops	3.358	0.001	***	-	-	0.012
Public transport stops	-	-	-	0.002	**	0.000
Schools	-	-	-	0.000	***	0.018
Month	-	-	-	0.000	***	-
Day	2.764	0.006	**	0.002	**	-
Hour	3.141	0.002	**	0.000	***	0.000

***Denotes significance at <1%, ** at 1%, * at 5% and . at 10%.

Table 3. (continued)

	House robbery		Business robbery		Vehicle theft		Robbery					
	Z stat.	Pr(> z)	Z stat.	Pr(> z)	Z stat.	Pr(> z)	Z stat.	Pr(> z)				
(Intercept)	60.120	0.000	***	69.740	0.000	***	58.074	0.000	***	34.234	0.000	***
Mayoralty	-	-	-	4.969	0.000	***	-	-	-	13.536	0.000	***
Land use	4.652	0.000	***	10.577	0.000	***	4.625	0.000	***	3.990	0.000	***
Clandestine dumps	5.932	0.000	***	-	-	-	11.290	0.000	***	8.885	0.000	***
Convenience stores	6.829	0.000	***	21.199	0.000	***	2.801	0.005	**	7.294	0.000	***
Bank branches	10.232	0.000	***	13.677	0.000	***	14.957	0.000	***	6.462	0.000	***
Bars	-	-	-	20.616	0.000	***	8.979	0.000	***	3.322	0.001	***
Restaurants	1.836	0.066	.	11.097	0.000	***	3.860	0.000	***	11.372	0.000	***
Pawn shops	-	-	-	10.848	0.000	***	-	-	-	3.039	0.002	**
Public transport stops	3.975	0.000	***	7.897	0.000	***	3.860	0.010	*	18.033	0.000	***
Schools	-	-	-	8.763	0.000	***	2.819	0.005	**	3.388	0.001	***
Month	1.726	0.084	.	6.480	0.000	***	6.171	0.000	***	4.657	0.000	***
Day	-	-	-	2.813	0.005	**	-	-	-	4.151	0.000	***
Hour	-	-	-	15.827	0.000	***	10.448	0.000	***	1.825	0.068	.

***Denotes significance at <1%, ** at 1%, * at 5% and . at 10%.

Table 3. (continued)

	Homicide		Assault		Rape		Domestic violence	
	Z stat.	Pr(> z)	Z stat.	Pr(> z)	Z stat.	Pr(> z)	Z stat.	Pr(> z)
(Intercept)	53.151	0.000	***	0.000	***	0.000	***	0.000
Mayoralty	6.718	0.000	***	0.000	***	-	***	0.000
Land use	-	-	-	0.001	**	-	-	-
Clandestine dumps	2.281	0.023	*	0.070	.	-	7.360	0.000
Convenience stores	9.825	0.000	***	0.001	**	-	29.059	0.000
Bank branches	6.923	0.000	***	0.000	***	0.003	20.959	0.001
Bars	-	-	-	-	-	-	6.114	0.000
Restaurants	7.068	0.000	***	0.000	***	-	21.300	0.000
Pawn shops	-	-	-	-	-	-	-	-
Public transport stops	-	-	-	-	-	-	11.361	0.000
Schools	-	-	-	0.066	.	0.074	-	-
Month	-	-	-	-	-	0.008	7.292	0.000
Day	-	-	-	-	-	-	-	-
Hour	9.862	0.000	***	0.088	.	0.007	18.740	0.000

***Denotes significance at <1%, ** at 1%, * at 5%, and . at 10%.

Table 4. Ranking of Variables' Relevance as Crime Predictors.

Stepwise Logit						
	Dispossession	Environmental crimes	Property damage	House robbery	Business Robbery	Vehicle theft
1	Banks	Hour	Hour	Banks	Convenience stores	Banks
2	Bars	Mayoralty	Clandestine dumpsites	Convenience stores	Bars	Clandestine dumpsites
3	Land use	Month	Banks	Clandestine dumpsites	Hour	Hour
4	Clandestine dumpsites	Convenience stores	Restaurants	Land use	Banks	Bars
Naïve Bayes classifier						
1	Banks	Restaurants	Restaurants	Restaurants	Banks	Banks
2	Restaurants	Hour	Banks	Banks	Convenience stores	Restaurants
3	Public transport stops	Convenience stores	Hour	Public transport stops	Restaurants	Bars
4	Clandestine dumpsites	Mayoralty	Clandestine dumpsites	Clandestine dumpsites	Public transport stops	Clandestine dumpsites

Table 4. (continued)

Stepwise Logit					
Robbery		Homicides	Assault	Rape	Domestic violence
1	Public transport stops	Hour	Mayoralty	Banks	Convenience stores
2	Mayoralty	Convenience stores	Banks	Hour	Restaurants
3	Restaurants	Restaurants	Restaurants	Month	Banks
4	Clandestine dumpsites	Banks	Land use	Public schools	Hour
Naïve Bayes classifier					
1	Restaurants	Banks	Restaurants	Banks	Banks
2	Public transport stops	Convenience stores	Banks	Restaurants	Restaurants
3	Clandestine dumpsites	Restaurants	Mayoralty	Month	Convenience stores
4	Convenience stores	Mayoralty	Bars	Hour	Public transport stops

order to classify the outcome as one (type of crime) in particular. In other words, it generates a measure of how a variable (or control) is independently responsible for predicting an outcome. This measure is then used to calculate variable importance. For simplicity, and in line with that reported for the stepwise logistic models, Table 4 also shows the first four positions of the ranking obtained using the Naïve Bayes classifier, rather than reporting the variable importance.

Table 4 shows that in two of the three property related crimes considered (dispossession and property damage), clandestine dumpsites are located among the top positions for predictive relevance. Clandestine dumpsites also ranked within the top positions for relevance for three of the four crimes related to robbery (house robbery, vehicle theft, and robbery), while they did not appear to have a particular predictive value for any of the individual related crimes.

As has been observed, clandestine dumpsites serve to support the BWT to some degree, that is, how a minor administrative offense may be associated with the commission of more serious crimes. Within this context, the crimes related to clandestine dumpsites fall into two categories: crimes associated with the physical characteristics of the clandestine dumpsites themselves, and different types of robbery (house, vehicle, and passerby).

From a physical point of view, clandestine dumpsites do not appear to be associated with any type of (major) crime, but rather, with crimes directly related to property. For example, one of the crimes associated with clandestine dumpsites is dispossession. This makes sense when considering that the presence of a clandestine dumpsite suggests the non-existent or limited monitoring of activities in the area. A clandestine dumpsite may be one of the most visible manifestations of environmental degradation and lack of social control (Steenbeek & Hipp, 2011). In Mexico City, a clandestine dumpsite appears to usually result from one particular phenomenon: the concentration of homeless people who occupy public spaces (streets, entrances, among others), and waste pickers who attempt to secure some income from the waste. Generally, the waste pickers also live in or around the area in order to be near the clandestine dumpsite. It is intuitively easy to assume that areas around them thus become a “no-man’s land” (Gault & Silver, 2008), with the frequent dispossession and illegal occupation of land or neighboring properties (buildings and houses).

These “no-man’s lands” not only reduce or directly eliminate neighborhood surveillance (eyes on the street), but also decrease social efficacy in many ways: there is less patrolling, residents avoid walking near clandestine dumpsites, fear negatively affects collective efficacy and territoriality (Pitner et al., 2012) and even if the police are called, the response is likely to be slower than in other neighborhoods (Kelling & Coles, 1997). At the same time, as

clandestine dumpsites are generally located in empty spaces (abandoned or public land) with low social monitoring, a form of feedback loop is created. These sites accelerate and promote greater abandonment of properties in their surrounding areas due to the pauperization and degradation of the public space.

Similarly, the association found between clandestine dumpsites and property damage may also appear intuitive. As in the previous case, a feedback loop is created of clandestine dumpsites, property damage (vandalism and graffiti) and abandoned properties. Property damage appears to be one of the most important crimes related to broken windows within the context of social disorder. Vandalism is a sign of broken windows, and interestingly, the physical and material environment appears to influence the impact of people's behavior on their own surroundings.

The presence of clandestine dumpsites creates an environment in which property damage is normalized. That is, a disordered social environment might even promote more disorder (Cozens et al., 2002). This is at the heart of BWT: the physical environment can foment or discourage opportunities for the commission of a crime, and clandestine dumpsites are a clear and open sign of no-man's land, where anything can be done without consequences. They represent a red flag for the lack of importance placed on and interest shown in the maintenance and care of an area by the community and/or the police force (Wyant, 2008). In fact, "social disorder," represented by clandestine dumpsites, may be the first step in a descending spiral of urban decay (Skogan, 2012). The incidence of "disordered" behavior, such as waste disposal, increases the possibility of property damage (vandalism and graffiti) in its surroundings, and in turn, property damage feeds back the possibility for more waste to be disposed of in clandestine dumpsites (Keizer et al., 2008).

Given the above, perhaps the most interesting of our results shows that clandestine dumpsites are strong predictors of three types of robbery (car, house, and passersby). In contrast to dispossession and property damage (that may be understood as somewhat lesser crimes), robberies reflect the explanatory capacity of BWT, at least in relation to clandestine dumpsites. It is perfectly understandable that a clandestine dumpsite creates a sensation of enough impunity to result in the occupation of an abandoned lot (dispossession), the vandalization of a house, or the graffitiing of a building (property damage), but robbery is a major crime and in addition, it is central to the BWT. It is precisely for this reason that in these areas, it is understandable that the commission of a crime is generally linked to certain rational planning.

The choice of these geographical points to commit a robbery appears to make sense: neighbors are unlikely to react, and police are likely to take a while to respond to a crime. Environmental degradation is linked to a lower social and institutional capacity (Warner, 2007). This leaves a possible

offender only with the challenge of finding a victim (who may be a car, house, or passerby), as they have already been presented with the opportunity by the social environment. It is thus interesting to observe that for the crime of robbery of businesses, where presumably there is a constant flow of people and more care is taken of the visual environment, clandestine dumpsites do not appear to have a major predictive capacity. In fact, they occupy the last position of importance in constructed rankings.

Finally, our results show that signs of public disorder (Sampson & Raudenbush, 2004), and in particular, clandestine dumpsites, although perhaps indicative of criminal opportunities, are unlikely to be associated with crimes where individuals are targeted (homicides, rape, assault, and domestic violence), that is, crimes that are not property crimes, but rather crimes with other motivations (sexual, emotional, among others), and generally committed without planning. While it may be assumed that a degraded social environment can motivate all classes of crimes, our findings point only to presumably planned property crimes. This may perhaps be due to the contingent nature of perceptions of disorder and their individual interpretation (Spelman, 2004), or to non-observable individual characteristics of residents in a neighborhood (Harcourt & Ludwig, 2006).

Degradation, and poor organization and social monitoring do not impact personal crimes, possibly because they operate with a different logic, or because there is no objectivity in the incidence of disorder (Franzini et al., 2008; Twigg et al., 2010). This finding is as important as the previous as it suggests that social disorganization does not appear to impact personal crimes. While presumably clandestine dumpsites are found in socially degraded sectors, the associated public disorder does not appear to be an important predictor of this type of crime. This is perhaps because individual stereotypes are contingent, and not directly related to, disorder for this type of crime (Sampson & Raudenbush, 2004). As a last possible explanation, even in low-income neighborhoods, it is possible that a certain degree of social cohesion (Morenoff et al., 2001) and crime control continues to exist for certain types of crimes. For example, social networks of alert in cases of sexual assaults that function as protection factors (Rader et al., 2012).

Concluding Remarks

This study seeks to fill a gap in the literature regarding specific manifestations of social disorder. In this regard, focusing on clandestine dumpsites is fundamental as they are an important sign of social degradation, and appear to concentrate and provide a different indication of the extent of disorder. A clandestine dumpsite creates a “no-man’s land” of its surroundings, where it

becomes possible to commit certain crimes without any real risk of apprehension. Our results show that the presence of clandestine dumpsites have a predictive capacity for property related crimes and robbery, while they do not appear to have this capacity for individual related crimes. This is in line with the main theories of social disorganization and the BWT, although it also suggests certain limitations on the explanatory capacity of social disorder for crimes that are not economically motivated.

Public policy in Mexico related to the reduction of public disorder was well received and translated into important changes on a legislative level and for street policing. In fact, in 2002, a group of Mexican businesspeople hired the Giuliani Partners LLC firm to advise the Mexico City government. The consultants deliver a report containing 146 recommendations that were a replica of the zero-tolerance strategy implemented in New York during Rudolph Giuliani's administration (Greene, 1999).

Recommendations included an entire public policy oriented toward eliminating public disorder, that ranged from decreasing environmental noise and eradicating prostitution, windshield cleaners, illegal parking attendants and street sellers, to the relocation of the homeless and street children. The elimination of clandestine dumpsites in the city, a graphic and visible representation of social disorder, was included within the battery of measures: a corner filled with trash, where even neighbors would throw all manner of waste, and where the absence and disinterest of State institutions was clear.

One of the main consequences of the report was the promulgation of the "Mexico City Solid Waste Law" in 2003, which, in article 10, section II, establishes that municipalities are responsible for "eradicat[ing] the presence of clandestine dumpsites of solid waste." In 2004, this resulted in the first "Program for the Integrated Management of Solid Waste for the Federal District." The program was the first public measure that openly included a concrete policy for the eradication of two types of clandestine dumpsites: recurring (the systematic improper disposal of solid waste), and occasional (improper disposal of solid waste in extraordinary circumstances).

The adoption and transformation of these recommendations into public policy had important consequences for the city, among which, "the widening of downtown's public sphere brought a narrowing of access to it along class lines" (Davis, 2013, p. 70). Nevertheless, one of the most resistant points of any public security and environmental policy on the matter was the clandestine dumpsites. In 2019, for example, there were still around 1,000 in Mexico City.

In terms of public policy, the findings are important as they emphasize the criminogenic role of clandestine dumpsites in a city that has struggled to eradicate them and that continuously tries to at least control their appearance.

Until now, the persistence and proliferation of clandestine dumpsites has been considered an environmental problem. According to the Program for Integrated Waste Management in Mexico City 2021–2025 (Secretaría del Medio Ambiente de la Ciudad de México, 2020), the Ministry for the Environment is responsible for eradicating 50% of the clandestine dumpsites, in coordination with the municipalities. However, this requires a comprehensive public policy that is not limited to environmental concerns, but that also incorporates public security issues, such as patrolling, emergency 911 calls, and of course, the creation of community alert networks and notifications for both neighbors and authorities, to reinforce social monitoring in these areas.

In Mexico City, clandestine dumpsites are an extremely complex social phenomenon that implies much more than the accumulation of trash in the corner of an economically marginalized neighborhood. It involves issues around cultural practices, as well as urban design, marginalization, and the concentration of institutional weakness in the management of the city, that manifest as clandestine dumpsites. As such, until now, the main instruments of public policy have consisted of awareness campaigns regarding environmental damage, and neighborhood clean-up days, both necessary but insufficient means of dealing with the issue. As such, it is worth including the Subsecretary of Citizen Participation and Crime Prevention in the coordination of activities to include the reconstruction of the social fabric and thereby improve collective efficacy.

The Subsecretary for Police Operations could also be involved in order that the Auxiliary Police can ensure that cleaned areas are not reconverted into dumpsites. Clandestine dumpsites should also be considered hotspots, with patrols to dissuade the commission of robberies, dispossession, and property damage. In sum, our findings should serve as valuable input for the formulation of a comprehensive public policy where the eradication of clandestine dumpsites become a means of improving citizen security and strengthening neighborhood organization and the social fabric.

Somehow, clandestine dumpsites are an omitted variable in the design of public policies to prevent crime. The findings of this research demonstrate the urgent need to expand vertical and horizontal coordination with other government agencies. They also illustrate that an environmental policy can generate positive externalities in terms of public safety. The institutional challenge is to convert these unplanned effects into regularities resulting from the coherence between two public policies from different policy domains.

Two limitations of the empirical strategy followed in this study relate to the tools used, in particular, the stepwise logistic regression. The first relates to the sensitivity regarding the choice of independent variables for

classification. On the other hand, as the classification methods were used to assess predictive relevance, our findings do not incorporate a temporal or spatial measurement of the association between the predictors and the types of crime. We recognize that these may represent a problem for the generalization of our results. In this sense, we recommend that any future extension to this work consider the association between clandestine dumpsites and the fear of crime, by including variables of perception of security in the neighborhood, as well as a time and spatial dimension. We also propose further exploring the relationship between social disorder and personal crimes (rather than economic), to determine whether an association exists between other forms of public disorder and these crimes, particularly in light of the fact that clandestine dumpsites may be a very specific phenomena occurring in countries like Mexico, and specifically in Mexico City, and not necessarily associated with other cities.

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