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The Impact of Street Morphology on Crime in Juja Town, Kiambu County

*** Shaquille Mburu, Stella Kasiva and Sunday Abuje**

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Abstract

In the urban realm, crime is concerned with the spatial aspect that is, the morphological dimension. Juja town has experienced three types of street crime: mugging, burglary, and theft. Therefore, this paper aims to identify and analyze the street morphology of the area in relation to crime. The study employed a descriptive research design. It sampled 84 streets in Juja town, Kenya, and analyzed their character through observation methods and interviews with respondents on crime incidences. The results show a correlation between street morphology and crime. It found that street morphology explained up to 35 percent variation in crime. Further, streets characterized by single-storey and double-storey structures enclosed by physical barriers such as fences experienced mugging and theft cases. Streets characterized by high-rise structures experienced theft and break-in cases. The study recommends that urban planners employ an organic street pattern approach. Further, local authorities should encourage mixed-used developments, to promote activities on the street through different times of the day. The provision of recreational zones, within residential zones characterized by single-storey and double-storey structures, would encourage a sense of community among residents, promoting passive surveillance and alleviating the fear of crime.

Keywords: Break in, crime, mugging, street morphology, typology, theft.

INTRODUCTION

Crime is a major threat to the quality of life and socio-economic stability of urban residents (Xiangyu, 2018). Globally, 62 percent of the population is expected to reside in urban areas by 2036, and therefore crime threatens sustainable development in cities (UN-Habitat, 2020). However, as more people opt to reside in cities, urban safety becomes increasingly important. The relationship between urbanization and inequalities of urbanity such as the wealth gap and access to green spaces has been explored and suggests that areas with inequalities are more likely to have high crime rates (Braithwaite, 2013; UN-Habitat, 2019)Crime is a major threat to the quality of life and socio-economic stability of urban residents (Xiangyu, 2018). Globally, 62 percent of the population is expected to reside in urban areas by 2036, and therefore crime threatens sustainable development in cities (UN-Habitat, 2020). However, as more people opt to reside in cities, urban safety becomes increasingly important. The relationship between urbanization and inequalities of urbanity such as the wealth gap and access to green spaces has been explored and suggests that areas with inequalities are more likely to have high crime rates (Braithwaite, 2013; UN-Habitat, 2019) such as: Is crime primarily an urban or rural phenomenon? Is crime concentrated in particular areas in the city? If so, is there an explanation for its spatial distribution? (Tume, 2010).

In Kenya, crime has threatened the physical and psychological well-being, livelihoods, and security of its citizens (Wetungu, 2010). The Security Research and Information Report (2014), notes that satellite towns experiencing exponential growth, especially of its middle class; who set up thriving businesses, without adequate security infrastructure, were prone to rampant crime incidences, attributing it to the socio-economic imbalance in the towns. Further, poor planning of settlements characterized by single entry and exit points, linked by long narrow streets as breeding grounds for criminal activities. These findings show a correlation between street morphology and crime incidence. Juja town exhibits dynamic

**Corresponding author:*
Shaquille Mburu *Jomo Kenyatta University of Agriculture of Science and Technology, Department of Landscape Architecture.*
Email: shaquillemburu@gmail.com

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growth indicated by an increased population from 40 thousand in 2009 to 156 thousand in 2019 (KNBS, 2019). This accelerated growth can be attributed to the existence of the only public university in Kiambu County. An increased population in a particular locality comes with an increase in societal vices such as crime (Ammissah, 2014). Increasing crime levels threaten the political stability of a locality, by undermining the rule of law, and threatening the peace of the residents (UNODC, 2010) This necessitates the increased allocation of resources toward combating crime and its prevention through environmental design.

This study investigates the relationship between street morphology and crime. It analyzes typological characteristics of structures along the streets in which crime occurs, to identify linkages between morphological characteristics and crime.

THEORY

Street morphology is termed as the physical characteristics of urban objects along the street; that constitutes the human habitat, and the complex interaction between each and their relationship as a whole (Oliveira, 2016). It is viewed as a hierarchy of urban clusters from the city to neighborhood scale, namely; urban fabric, urban block, urban canyon, and the urban microclimate.

The urban fabric is characterized by the relationship between the roads and the building footprints. Oikonomou (2014) defines an urban block as three-dimensional forms of buildings set on adjoining plots, engulfed by streets. This proximity creates a relationship between their spatial and social function. The urban canyon is formed between two urban blocks contiguous to the street (Marins, 2013). The urban microclimate is the climatic conditions existing within an urban locality such as neighborhoods, resulting from the urban fabric (Tsoka, 2020).

Dhita (2018) argues that there is a relationship between the urban fabric and crime. Further, the concept of crime in the urban realm is concerned with space and the functional attributes of the city. Crime is a multi-dimensional event encompassing both social and spatial aspects such as design patterns and spatial configurations. It occurs when a potential offender and its target object or person, converge in place and time (Heba, 2015).

The relationship between the built environment and crime has been widely explored, particularly in developed countries, with little focus on developing countries (Hipp, 2018; Sohn, 2015; Elgarmadi, 2018). Prior studies have focused on three spatial scales, that is microscale (street segment), mesoscale (neighborhood), macroscale (city), with the focus being on the microscale. Most studies have agreed on the influence of the built environment on crime rates arguing the areas that present physical sign of negligence and social disorder tend to encourage more crimes, as presented by the broken window theory (Wilson, 1982). This concept resulted in the development of urban design interventions, key of which is crime prevention through environmental design (CPTED), which aims to discourage criminal activity (Cozens, 2015).

The different concepts of crime as articulated in disciplines such as sociology, criminology, and urban design, indicate an extensive relationship between crime and urban morphological characteristics (Idris, 2022). According to Wuschke (2016) the morphological dimension of crime has been less explored as a function of urban form in relation to social and perceptual dimensions. Wuschke (2018) notes that the complexity of the city is a network of multi-scalar activities and crime that need to be explored in relation to various scales and dimensions, particularly the morphological dimension.

In urban areas, crime is concentrated in certain areas more than others and its frequency varies from one place to another, therefore, understanding crime patterns is critical in understanding urban crime. Barbaro (2013) argues that spatial mapping of crime events across the urban realm is essential in curbing this vice.

Previous studies argue that the physical environment, both built and natural environments, influences crime rates. Further, these environments determine the location of crime as certain facilities such as liquor stores or abandoned buildings are crime attractors. Moreover, these facilities determine the number and type of users which in turn modulates criminal activities (Omonya, 2020; O'Brien, 2015; Elodie 2017). In Kenya, the National Crime Research Centre (2017), notes that the main types of crime in Kenya by frequency include; theft at 15.6%, possession of illicit brew at

9.7%, assault at 8.8%, burglary at 7.6%, murder at 7.6%, rape at 7.2% and robbery at 6.8%. According to National Police Service (2018), Kiambu County ranked second nationally after Nairobi, in crimes registered which totaled 6,932 cases. Further, the leading types of crimes in Kiambu County are; mugging, burglaries, theft, and possession of narcotics. Nationally, Kiambu County accounts for 62% of mugging cases, 46% of burglaries, 40% of theft cases, and 38% of possession of narcotics cases (NCRC, 2018). According to Juja sub-county police records, mugging is the leading type of crime accounting for 45% of reported incidences, followed by theft at 21% and break-in at 12%.

The existing literature indicates a linkage between the physical environment and crime incidence. However, literature on the impact of the morphological dimension on crime in the context of Juja sub-county remains very scanty. Therefore, this study aims to explore the morphological dimension so as to understand crime patterns for towns in transition from informal settlements to high-density development urban areas and aid planners and designers prevent criminal activities through environmental design.

RESEARCH METHODS

The area of study is located in Kenya, Kiambu County, Juja Sub-County. The Juja ward is bordered by Ngenda Ward to the North, Witeithie Ward to the east, Kalimoni Ward to the South, and Theta Ward to the West as shown in **Figure 1**.

The study area is located in the Juja ward in the Juja sub-county. The Juja ward is also defined by a key transport corridor to the south, namely; Nairobi – Thika corridor, commonly referred to as the Thika superhighway. The study focused on the streets abutting the JKUAT's boundary and their feeder roads within 500 meters width from the boundary as shown in **Figure 2**.

The study adopted a mixed-method research design as it is suited for a study requiring both quantifiable data, assessing the magnitude and frequency of constructs, and qualitative data which explores the meaning of these constructs (Syed, 2016). This approach enabled the researcher to gather data on the built typologies abutting the streets and the crimes experienced along these streets. The study employed both probability sampling and non-probability sampling in the selection of a sample (Kothari, 2004). Probability sampling was used to sample the streets as it ensures that each subject in the universe has an equal chance of selection (Kothari, 2004). Further, stratified sampling was used as the area had three levels of streets, primary, secondary, and tertiary streets. This hierarchy was based on width, that is 15m, 9m, and 6m respectively. The study's universe totaled 106 streets as shown in **Figure 2**. The sample size was 84 streets.

Non-probability sampling was used in the selection of respondents. Syed (2016) argues that this approach assumes that subjects selected by the researcher represent the population of interest. Further, volunteer sampling was used in the selection of respondents, as they became available along the streets in the study area.

The study employed an observation method to collect data on street morphology. Syed (2016) notes that descriptive studies yield rich data as it collects large amounts of data and the subjects being observed are in their natural environment. The study used a semi-structured interview method to collect data on crime incidences along the streets in the study area as shown in **Table 1**. According to Mohammed (2016), this method is appropriate when the interviewer will not obtain another chance to interview the same respondent.

Data collected using completed questionnaires were checked for completeness and consistency and were coded. According to Kothari (2004), coding involves the assigning of alpha-numerical characters to responses to group them into a limited number of classes. The data was then entered into Statistical Package for Social Sciences (SPSS) software, version 21.0 for analysis. The study utilized both descriptive statistics (percentages and frequencies) and inferential statistics namely; correlation and regression models to analyze data.

The study performed correlation analysis to establish the nature of the relationship between street morphology and crime. Regression analysis was performed to further determine the degree to which street morphology explains crime incidence. The study also mapped these crimes on the streets on which they occurred, to analyze their typological characteristics.

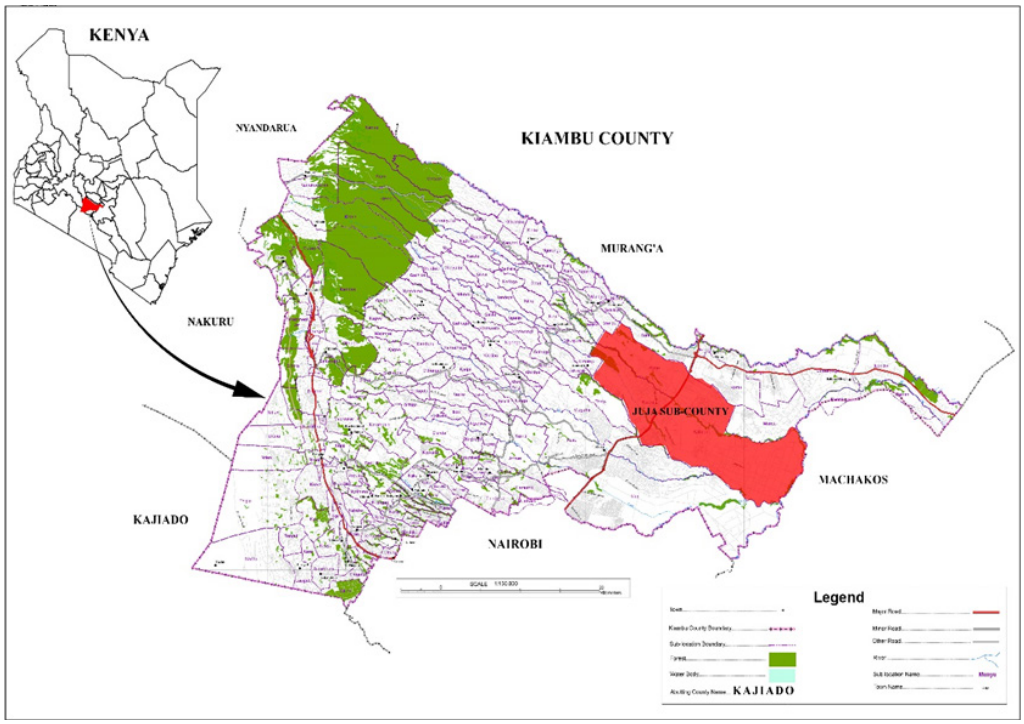


FIGURE 1
The context map of Kiambu County and Juja Sub-County
Source: Adapted from Planning department - Juja Sub-County 2022

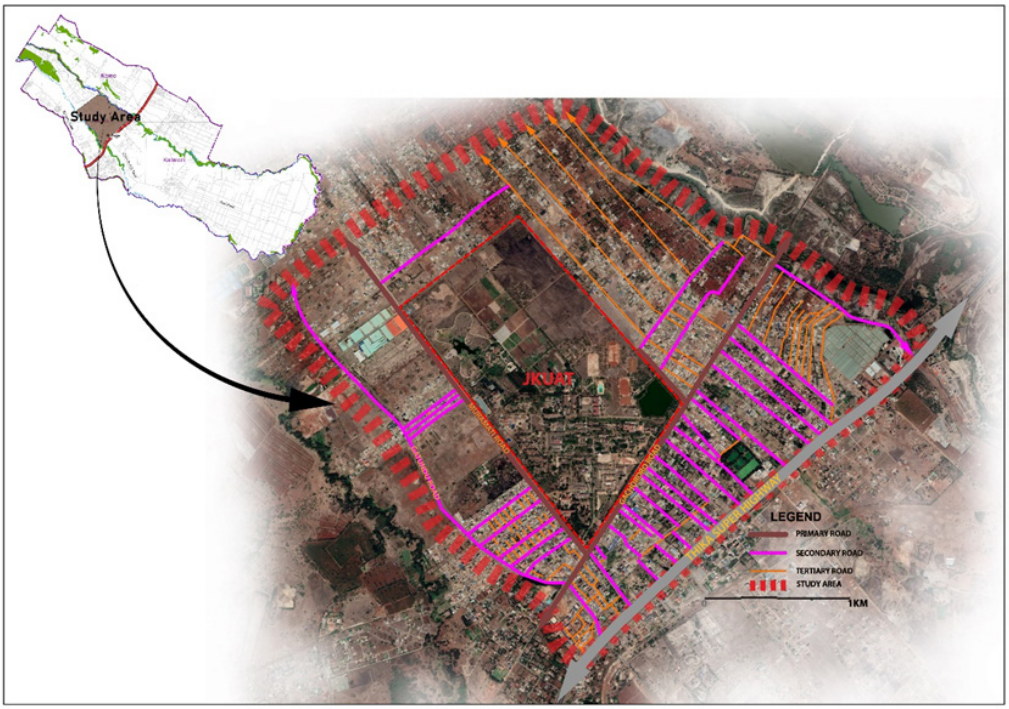


FIGURE 2
The study area context map in Juja Sub-County
Source: Adapted from Planning department - Juja Sub-County 2022

RESULTS AND DISCUSSION

The study focused on the interaction between the street, that is, its length and width, and the vertical component that is, the built structures abutting the street. It found out that the streets are of varying lengths, with the shortest being 45m and the longest street being 1.7km. However, the widths

FIGURE 3
Street hierarchy in the study area
Source: Adapted from Google Earth 2023

TABLE 1
The data collection methods

Observation Method	Investigate the built typologies of structures abutting the streets
Interview Method	Inquire from respondents on crime locations.

Source: Author 2023

of the streets are grouped into three categories, that is 6m, 9m, and 15m respectively. The 6m wide streets are the tertiary roads which account for 83%, whereas the secondary roads which are, the 9m wide roads account for 13% and the primary roads account for 4% of the road network as shown by **Figure 3**.that is 6m, 9m, and 15m respectively. The 6m wide streets are the tertiary roads which account for 83%, whereas the secondary roads which are, the 9m wide roads account for 13% and the primary roads account for 4% of the road network as shown by **Figure 3**.

These street categories had distinct characteristics as shown in **Table 2**: The streets in the study area are abutted by the built structures which are of different levels. The study grouped these levels into three categories namely, single-storey, double-storey, and high-rise. The predominant structures were high-rise structures at 44%, whereas single-storey structures account for 41% and double-storey units account for 15% as shown in **Figure 4**.

The study found that the area had 4 typologies abutting the three levels of streets as shown in **Table 3.** The study enquired on the locations of crime namely; mugging, theft, and break-in along the streets in the study area, and found the distribution as indicated by **Figure 5**. The study sought to explore the relationship between the street morphology and crime. The correlation analysis results between street morphology and crime reveal that there was a strong positive and statistically significant relationship, $r = 0.741$, $p = 0.039$, as shown in **Table 4**. This implies that the building typology abutting the street influences

the frequency of crime incidences.The regression analysis indicates that street morphology had a significant correlation to crime as shown in **Table 5**.

Linear regression between street morphology and crime, reveals that the morphology significantly explained a 35 percent variation in crime incidences as indicated by the coefficient of determination (R2) value of 0.350. The modelshows a statistically significant linear relationship at a 95 percent confidence level as illustrated by **Equation 1**.

Eq. 1: Crime = 1.316 + -0.023 SM (1.0)
R2 = 0.350 SM = Street Morphology.

The prediction demonstrates that a unit increase in street morphology leads to a decrease in crime by -0.023 units. This implies the built typology, lowers the frequency of street crime. This can be attributed to the increased activity and natural surveillance on the street which will deter potential offenders.

TABLE 2
Street hierarchy typologies

Hierarchy	Characteristics
Primary street	This street serves as an arterial road, with high vehicular and motorcycle traffic. It has a width of 15 meters and an asphalt material finish
Secondary street	This street serves as a collector road, with lower intensity of vehicular traffic but a high motorcycle and pedestrian traffic. It has a width of 9 meters and an earth material finish.
Tertiary street	This street serves as a neighborhood road, with high pedestrian traffic. It has a width of 6 meters and an earth finish material.

Source: Author 2023

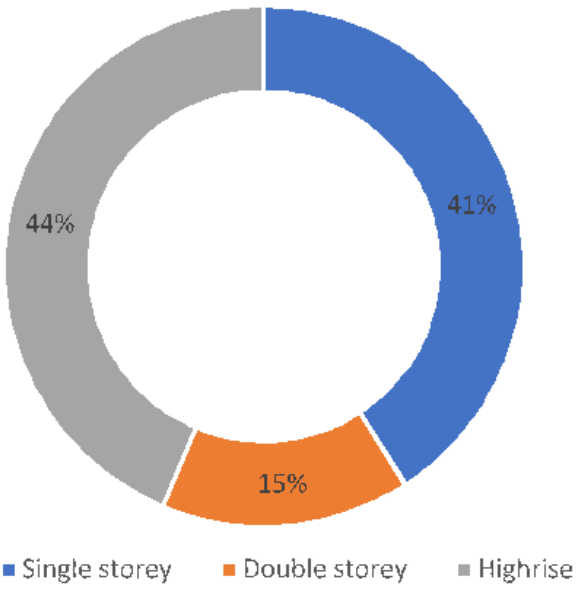
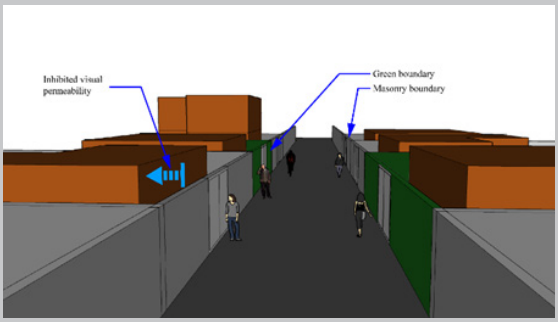
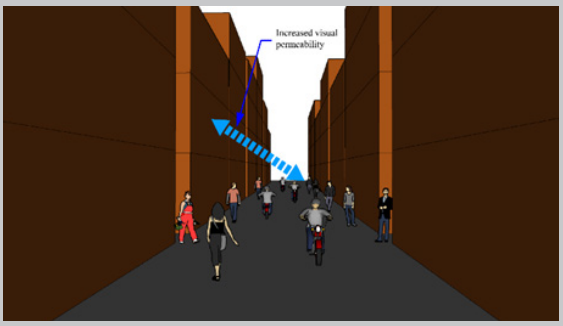
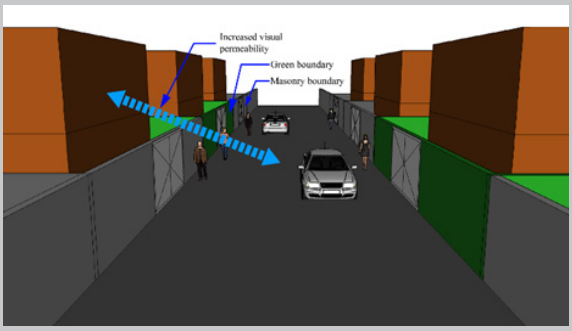
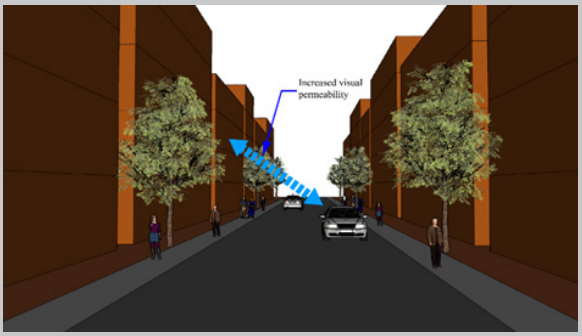


FIGURE 4
The study area context map in Juja Sub-County
Source: Author 2023

TABLE 3
Built typologies in the study area

Typology	Descriptions
 Typology A	This typology is located along neighborhood streets. The streets have a width of 6 meters and are dominated by single-storey structures. The structures are fenced using masonry or vegetation creating a sense of enclosure and inhibiting surveillance on the street. The street is characterized by pedestrian traffic.
 Typology B	This typology is located along the neighborhood street and which have 6 meters width. The streets are engulfed by high-rise structures. The street experiences high pedestrian and motorcycle traffic. These streets have increased surveillance, due to increased visual permeability.
 Typology C	This typology is located along secondary streets which are 9 meters wide. The streets are abutted by double-storey structures. These structures are enclosed by masonry and vegetative boundary, which allows for visual permeability from the floors above. The wider width encouraged increased vehicular and pedestrian traffic which encourages passive surveillance.
 Typology D	This typology is located along primary streets, which have a width of 15 meters. The streets are abutted by both high-rise structures. These structures have increased visual permeability and therefore more 'eyes on the street.' The increased width encourages increased motorized and pedestrian traffic which promotes passive surveillance.

Source: Author 2023

FIGURE 5
Crime distribution along the streets
Source: Author 2023

TABLE 4
Correlation summary between street morphology and crime

Code	Independent Variable	Coefficients	Conclusion
SM	Street Morphology	r = 0.741	There is a significant correlation
		p = 0.039	Reject the null hypothesis

Source: Author 2023

TABLE 5
Summary of regression results

S/No	Y Variable	βo	Street Morphology	Adjusted R2	F- Value	P- Value	Percent (%)
1	Crime	1.316	-0.023	0.350	1.011	0.019	35

Source: Author 2023

DISCUSSION

Idris (2022) defines street morphology as the typological processes (urban design and form) that deal with public space network, space, and place issues. Abdul (2017) opines that the built physical form of urban areas in particular can either encourage or constrict movement along predetermined pathways that connect points of origin and destinations and thereby encourage or prevent crime. Wuschke (2018) supports this study by arguing that the urban structure not only shapes movement patterns but also criminal activity. Morphological processes such as urban development, growth, or gentrification have a considerable impact on the distribution of criminal activity.

Silva (2020) argues that the urban form dictates the crime patterns, noting that cities portraying gridiron patterns experience higher crime rates than organic street layouts. Baorui (2020) agrees that gridiron street networks have an excessive number of intersections and short distances, which encourages 'through' traffic, undermining the security of entry and exit points.However, according to Amiri (2019) streets with complex street networks such as curvilinear loop patterns experience more crime as they are difficult to navigate both by pedestrians and security officers. Further, Cities with concentric zonal forms portray concentrated crime locations towards the dense core of the city.

The area of study exhibits a gridiron street pattern with high connectivity **Figure 6** and therefore increased crime incidence. This is was attributed to the high connectivity due to increased

FIGURE 6
The plot pattern in the study area
Source: Author 2023

intersections at short distances which dictates the distribution of crime, further agreeing with the crime pattern theory (Brantingham, 1993).

Amiri (2019) argues that dense neighborhoods experience higher crime rates especially break-ins, because compact neighborhoods tend to diminish passive surveillance between houses while increasing social friction. Silva (2020) notes that less dense neighborhoods with higher open space density improve passive surveillance, reducing crime incidence.The study concours with these findings as break-ins cases were reported in dense neighborhoods with high rise structures. Further low-density neighborhoods with open spaces had streets with no crime reported as they tend to promote better walkability and improved passive surveillance.According to Dhita (2018), street morphology influences the level of crime in a given area. Moreover, semi-public streets of widths between 5 – 8m, in residential zones, that are enclosed by single-storey structures with physical barriers on either one or both sides of the street, were less secure and experienced crime rates of between 10 – 30%. The study points further, that public streets of widths between 9 – 15m, in commercial zones, abutted by double-storey and high-rise typologies experienced higher crime rates, over 30%.

The current study supports these findings as the results indicate a significant and strong positive correlation between building typology and crime, as indicated by the correlation coefficient ($r = 0.741$, $p = 0.039$). However, this study found that streets abutting high-rise structures had low crime incidences, whereas streets lined with single-storey and double-storey structures had higher crime incidences as shown in **Figure 7**. Umar (2017) argues that crime is clustered at both the microscale level (street segment) and the mesoscale (neighborhood) spatial scales.

Further, the significant clustering of crime at the mesoscale was part explained by the clustering at the microscale, and therefore micro geographic units are key to understanding urban crime patterns (Steenbeek, 2015).

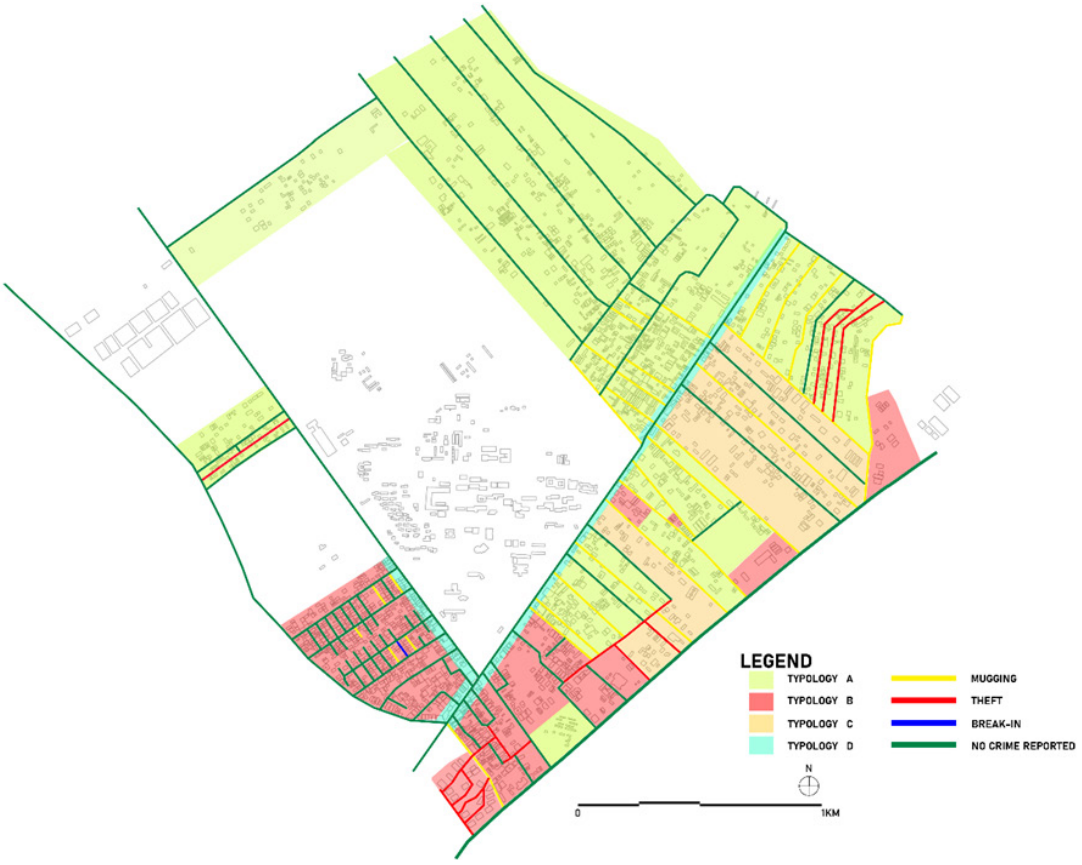


FIGURE 7
Overlaid map of built typology and crime distribution
Source: Author 2023

The study supports these prior studies as it found that mugging and theft incidences were clustered along streets abutting single-storey and double-storey structures. This was attributed to the narrow width of 6m which discourages activities and physical barriers that inhibit visual permeability and therefore passive surveillance. However, theft and break-in incidences were clustered along streets abutting high-rise structures which was attributed to a low built density hence reduced activity on these streets and therefore reduced passive surveillance. Therefore, these findings support the law of crime concentration at places (Weisburd, 2015) which applies in the context of Juja town.

CONCLUSION

The study sought to establish linkages between street morphology and crime patterns in Juja town. Empirically, street morphology shows strong positive correlation to crime and explains up to 35 percent variability. This implies that street morphology is substantially associated with crime rates. Specifically, streets abutting single-storey and double-storey structures are prone to higher crime cases, particularly mugging and theft cases which were attributed to reduced passive surveillance. However, streets defined by high-rise structures experienced lower mugging rates but higher break-in and theft cases, which was attributed to reduced visual permeability to adjacent structures.

RECOMMENDATIONS

From the above findings, this study recommends that urban planning should encourage a curvilinear loop street pattern approach to planning, as opposed to the existing gridiron street pattern as it has increased intersections at short distances increasing permeability. Further, local authorities should encourage mixed-used developments, to promote activities on the street through different times of the day, encouraging passive surveillance. The provision of recreational zones, within residential zones characterized by single-storey and double-storey structures, would encourage a sense of community among residents, promoting passive surveillance and alleviating the fear of crime.

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