

# Assessment of the Effect of Nighttime Lighting on Crime Incidence on a University Campus Using GIS Techniques



M. O. Idrees<sup>1, 2\*</sup>, M. O. Abisodun<sup>1</sup>, R. W. Mayowa<sup>3</sup>, L. T. Ajibade<sup>4</sup>

<sup>1</sup>Department of Surveying and Geoinformatics, Faculty of Environmental Sciences, University of Abuja, Nigeria.

<sup>2</sup>Department of Surveying and Geoinformatics, Faculty of Environmental Sciences, University of Ilorin, Nigeria.

<sup>3</sup>Department of Urban and Regional Planning, Faculty of Environmental Sciences, University of Ilorin, Nigeria.

<sup>4</sup>Department of Geography and Environmental Management, Faculty of Social Sciences, University of Ilorin, Nigeria.



**ABSTRACT:** In recent years, University campuses have grown more diverse throughout Nigeria; however, with attendant security challenges. This study investigates the relationship between crime and nighttime illumination in the University of Ilorin Campus using GIS techniques. Geospatial datasets including the road network, buildings, illumination sources (streetlights), and location of historical crime spots were collected and converted into a geodatabase for analysis. First, average nearest neighbor (ANN), point density (PD), and kernel density point analysis were applied to determine the distribution pattern and nighttime lighting intensity. Subsequently, by overlaying the crime spots data layer and nighttime illumination map, the relationship between them was determined using percentage of agreement statistics. Analysis of the spatial distribution of streetlights indicates a clustered pattern with an ANN value of 0.575 and a Z-score of -23.131. Also, statistical evaluation has shown that almost 70% of crimes occurred in poorly illuminated areas, under the cover of darkness. The findings highlight a critical intersection between public safety and urban planning at the University of Ilorin. By addressing the challenges posed by inadequate lighting through public power supply, the university can enhance security, foster a vibrant campus life, and reduce crime rates. Investing in reliable and sustainable lighting solutions promotes safety and contributes to the overall well-being of the campus community.

**KEYWORDS:** Crime zones, Geographic Information System, Nighttime illumination, Streetlights.

[Received Dec. 8, 2024; Revised July 7, 2025; Accepted July 18, 2025]

Print ISSN: 0189-9546 | Online ISSN: 2437-2110

## I. INTRODUCTION

Universities function as micro-urban communities with the tradition of nightlife activities that stimulate the night-time economy and urban vitality which has rejuvenated a new round of consumption upgrading potential. The nighttime economy allows residents to meet their demand for quality and diversity of consumption (Fan et al., 2024; Ramello, 2023). Nevertheless, excessive development of the nighttime economy has brought about some complications, such as land use conflicts and loss of labour, (Wang et al., 2022). Similarly, the profligate culture promoted by nightlife includes an increase in crime such as theft, robbery, and sexual assault. Because of the economic and social effects of the night-time economy, it has increasingly attracted research interest in recent years. The study of the concept of the nighttime economy was first instigated by Chatterton and Hollands (Chatterton & Hollands, 2002) who methodically analysed a theory of production, regulation, and consumption of urban nightlife space. However, the nighttime economy comes with its challenges. In the routine activity theory, it is posited that

increased night-time activity could potentially provide opportunities for criminal activities. An increase in the night-time economic vitality of a city increases the night-time lighting.

According to behavioural economists, human emotions and behaviours are predisposed to environmental influences (Belsky, 2013; Bouchard & McGue, 2003).). In this context, MacDonald (2015) observed that changes in the physical design of public places can influence the crime rate. The study of Romice et al. (2017) concludes that the social and physical characteristics of urban landscapes play vital roles in criminal activity. In a related study, Zhou et al. 2019 found that night-time lighting gradient affects the rate of street robbery. In addition, by investigating the effect and mechanism of nighttime light brightness on the urban crime rate in China, Peng et al. (2022) observed a link between an increase in night-time light brightness by 1% and the criminal arrest rate. Crime is not limited to towns and cities; it happens wherever people converge to carry out their daily activities. Insecurity, as manifested in varied forms has become a major challenge globally and particularly in developing countries. In Nigeria,

\*Corresponding author: [mbenghanem@iu.edu.sa](mailto:mbenghanem@iu.edu.sa)

doi: <http://dx.doi.org/10.63746/njtd.v22i5.3158>

insecurity comes in different forms ranging from kidnapping, armed robbery, burglary, low-level civil disorder, and large-scale violence to armed insurgency among others (Igbinedion & Ebomoyi, 2017). These have created fear, anxiety, and damage to lives and properties. Specifically, individuals and society suffer various consequences of insecurity and crime, these are manifested in loss of income, property loss, and loss of productivity and/or investments, etc (Ojo & Ojewale, 2018). Some other costs of crime, which are less tangible; include psychological trauma on victims and their families and friends, pain and suffering, and a lower quality of life.

From related literature, urban criminality can be curbed using preventive and curative strategies; however, it has been found that the preventive approach is better because it is cost-efficient and citizen-friendly (Sanidad-Leones, 2006). A recent study conducted by the Inter-American Development Bank on crime in 17 countries across Latin America and the Caribbean found that the average costs of crime represented 3.55 percent of the region's gross domestic product, in contrast to less than 1.4 percent in Germany and 2.75 percent in the United States UNODC (2021). The disparity in crime-related costs indicates a substantial financial burden that can hinder economic growth, reduce investments in social services, and impact overall quality of life. Investing in crime prevention strategies and improving security measures could lead to better economic outcomes and enhanced social stability.

Higher institution of learning is microcosm urban settlement. The social environment and age group of the Nigerian campus communities highlight why the crimes such as rape, theft, cybercrime, cultism, and burglary have experienced a rapid increase in recent times (Badiora 2017). Studies have revealed that the increase in crime rates on campuses creates tremendous challenges for campus security (Ekpoh et al., 2020). Campus crimes damage the reputation of institutions and undermine the security of the environment. Thus, the university authorities are often under pressure to provide effective security, keep on track, and upgrade their protective systems for a safe environment. Even though campus crime has been well-studied (e.g., Badiora 2017; Ekpoh et al., 2020; Fisher & Sloan, 2022), the environmental factor of nighttime lighting has received little attention. This study investigates the relationship between nighttime lighting and crime incidents on the University of Ilorin campus. The contributions of this study are to explore the impact of street lights on the nighttime illumination on the Campus and the link between crime incidents and illumination patterns.

## II. THEORETICAL AND CONCEPTUAL FRAMEWORK

This study is anchored on two interrelated criminological and environmental design theories -Routine Activity Theory and Crime Prevention Through Environmental Design (CPTED), as well as the growing body of literature emphasizing the role of urban lighting and spatial analysis in crime prevention. These frameworks provide a theoretical lens through which the relationship between nighttime lighting and crime incidence can be analysed, particularly within micro-urban environments such as university campuses. Routine Activity Theory, originally proposed by Cohen and Felson (1979), posits that

the occurrence of a crime depends on the convergence of three elements: a motivated offender, a suitable target, and the absence of a capable guardian. In campus environments, nighttime activities often increase the potential for such convergence, especially in poorly lit areas where natural surveillance is low. Lighting serves as a form of "capable guardianship" by increasing visibility, deterring potential offenders, and promoting a sense of safety (Chatterton & Hollands, 2002; Romice et al., 2017). Inadequate lighting may inadvertently facilitate crime by creating conditions conducive to criminal opportunity without sufficient risk of detection. Closely linked to Routine Activity Theory is the CPTED framework, which suggests that the physical design of spaces, such as lighting, visibility, and access control, can directly influence human behaviour and reduce the likelihood of criminal activity (MacDonald, 2015). According to this framework, well-lit environments are less attractive to criminals, as they increase the likelihood of being observed or apprehended. Urban design interventions that enhance visibility and territorial reinforcement, such as proper lighting in pathways and open spaces, are considered effective in reducing crime rates (Romice et al., 2017).

From a spatial perspective, human behaviour and criminal incidents are influenced by both the social and physical structure of space (Zhou et al., 2019). Several studies have empirically established the association between lighting gradients and crime patterns, showing that improved nighttime illumination leads to reduced incidents of theft and assault in urban areas (Peng et al., 2022; Kamalov, 2020). GIS-based spatial analysis methods such as Kernel Density Estimation (KDE) and Average Nearest Neighbor (ANN) further support this by offering tools to map and model crime hotspots relative to illumination levels (Aumüller et al., 2020; Shuo et al., 2021). In the university context, campus lighting is not merely a utility issue but a security infrastructure that mediates the relationship between environmental conditions and student safety. Theoretical understanding suggests that when lighting infrastructure is inadequate, particularly in areas where late-night social or academic activities occur, students become more susceptible to opportunistic crimes such as theft and assault (Badiora, 2017; Ekpoh et al., 2020). Therefore, by applying these frameworks, this study conceptualizes the relationship between nighttime illumination and crime as a spatial phenomenon, where variations in lighting intensity influence the spatial distribution and frequency of crime on campus.

## III. MATERIALS AND METHOD

### A. The Study Area: University of Ilorin

The University of Ilorin, established in 1975, is in Ilorin, the capital city of Kwara State, Nigeria. The university has a landmass of about 5,000 hectares and the part covered by this work is located between longitude 4° 39' 00" E to 4° 41' 30" E and latitude 8° 27' 30" N to 8° 30' 0" N, which constitutes the core developed area (Figure 1). Initially founded as a university to cater to the educational needs of the northern region (Sanchi, 2022), it has since grown into one of Nigeria's leading higher education institutions (Suleiman et al., 2022). The university is known for its emphasis on academic

excellence and has a reputation for a diverse range of programs across various fields, including the sciences, humanities, social sciences, health, and environmental sciences. Over the years, the University of Ilorin has developed a strong reputation for its commitment to research, innovation, and community service. It is recognized for maintaining a relatively peaceful campus environment, which has contributed to its attractiveness for students across Nigeria and beyond. The university's dedication to quality education and its robust academic community continue to enhance its standing in the national and international education landscape.

The campus community at the University of Ilorin reflects a diverse socioeconomic status, largely comprising students from various backgrounds, including lower, middle, and upper classes. Many students are supported by families involved in agriculture, trading, or civil service, while others may receive scholarships or financial aid. The population of the university itself is substantial, with over 40,000 students enrolled (Suleiman et al., 2022), alongside a significant

number of faculty and staff. This diverse demographic contributes to a vibrant academic and social environment. In terms of crime levels, the University of Ilorin generally maintains a relatively low crime rate compared to other institutions in Nigeria (Balogun et al., 2024). However, like any university campus, it is not entirely immune to issues such as theft, harassment, or petty crimes, particularly in poorly lit areas. The university administration has implemented various security measures to enhance safety and address these concerns, creating a focused effort to promote a secure campus environment for students and staff.

#### B. Data Used and Sources

For this study, three major datasets were utilized. They include the locational (x, y) coordinates and attributes of the streetlight, high-resolution Google Earth image, and crime inventory data (Table 1).

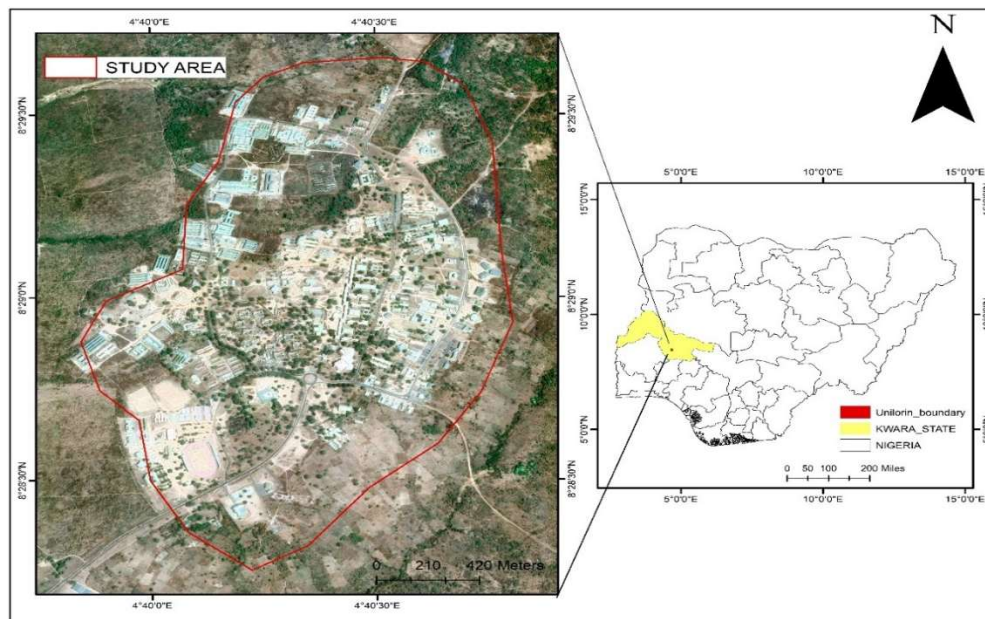


Figure 1 Location of the study area

Table 1 Data used, sources, and their properties

S/N	Data	Sources	Description
1	High-resolution Image	Google Earth Pro	Acquired November 2021. Using the high-resolution earth image, the roads, buildings, and parks were digitized in ArcGIS desktop.
2	Location and attributes of streetlights	GPS Field measurement	Locations of the streetlight poles and their attributes within the study area from which the point data are generated and spatial pattern analyses are made.
3	Crime inventory data	Students' Affairs Unit of the University of Ilorin	Areas where crime activities had happened within the University of Ilorin based on the record

### C. Data collection and processing

The xy coordinates of all the streetlights were collected using a Garmin 76X handheld GPS receiver. In addition to the locational data, attributes of the streetlights such as the pole heights, the types of bulbs, and the lighting coverage area were documented. The streetlight system is the major source of illumination at night (Kanthi & Dilli 2023) which promotes security and increases the quality of life by artificially extending the hours in which activities take place on the campus. Overall, a total of 810 streetlights are present in the study area; 30 (4%) of which are solar-powered while the remaining 780 (96 %) are powered by electricity. Also, from the high-resolution Google Earth Image, the road network and building layers were

derived through desktop digitizing. For the crime data, we obtained the crime incidents inventory location data (in .kmz file format) from the Students Affairs Unit of the University. The datasets were converted into implementable spatial data formats in a GIS environment for spatial analysis.

We analysed the spatial pattern of the street light location data using ANN, kernel density (KD), and point density (PD). The resulting KD image was further reclassified into three classes depicting nighttime illumination intensity. Furthermore, the crime inventory data layer was overlaid on the illumination map to determine their relationship. The data processing and analysis steps are presented in Figure 2.

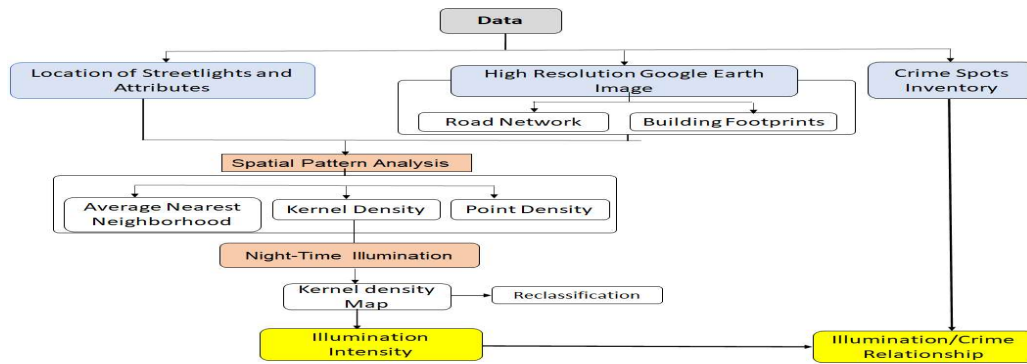


Figure 2: Overall methodological flow chart

#### 1). Spatial Pattern Analysis

Three different spatial analyses were carried out: Average Nearest Neighbor (ANN), Kernel Density (KD), and Point Density (PD). ANN measures the distance between the streetlights and its nearest neighbor's centroid locations and averages all the nearest neighbor distances of the streetlights to determine if the pattern observed is random, dispersed, or clustered (Aumüller et al., 2020). ANN examines the distance between each streetlight and the closest streetlight to the other and then compares these to the expected values for a random sample of streetlight points from a complete spatial randomness (CSR) pattern (Vovk, 2021). The output provides reports on the distribution of the points and numerical values that describe the extent to which the streetlights are clustered. The ANN is expressed in Equation (1):

$$ANN = \frac{\bar{D}_O}{\bar{D}_E} \quad (1)$$

where  $\bar{D}_O$  is the observed mean distance between each feature and its nearest neighbor as given in Equation (2) while  $\bar{D}_E$  is the expected mean distance for the features in a random pattern.

$$\bar{D}_O = \frac{\sum_{i=1}^n d_i}{n} \quad (2)$$

$$\bar{D}_E = \frac{0.5}{\sqrt{n/A}} \quad (3)$$

where  $d_i$  represents the distance between a streetlight and its nearest neighbor,  $n$  is the total number of streetlights and  $A$  is

the area of the study region. The KD calculates the density of points around each output raster cell. Only the points within the neighborhood are considered when computing density; where no point falls within the neighborhood of a particular cell, it is assigned as "No Data". The surface value is highest at the point location and diminishes with increasing distance away from the point, reaching zero at the search radius distance (Kamalov, 2020). KD can also be used to calculate line density. The output cell size was defined by a numeric value obtained from the raster data set. In the present case, the kernel density (Equation 4) was calculated using the default search radius.

$$Density = \frac{1}{(radius)^2} \sum_{i=1}^n \left[ \frac{3}{\pi} \cdot pop_i \left( 1 - \left( \frac{dist_i}{radius} \right)^2 \right)^2 \right] \quad (4)$$

where  $i = 1, \dots, n$  are the input points,  $pop_i$  is the population field value of point  $i$  which is an optional parameter, and  $dist_i$  the distance between point  $i$  and the  $(x, y)$  location while  $radius$  denotes the search radius.

The PD calculates the magnitude-per-unit area of points that fall within a neighbourhood around each cell. A total number of 810 streetlights were used in analysing the PD in this task. The algorithm defines the neighbourhood around each raster cell centre and the number of points that fell within the neighbourhood summed up and divided by the area of the neighbourhood (Boots & Getis, 2020). Unlike the KD, every streetlight in point density analysis is considered the same for the entire search radius within the study area (Boots &



Getis.2020). The output presents the variation in the density in meters using a range of colour. In this study, the point density has a cell resolution of 1 m measured in a unit of pts/m<sup>2</sup>. The mean density is derived mathematically as expressed in Equation 3.5.

$$\bar{D} = \frac{1}{n_r} \cdot \sum_{i=1}^{n_r} D_i \quad (5)$$

Where  $D_i$  = the density of the point,  $n$  = the number of neighbor point  $\bar{D}$  = mean density (point/m<sup>2</sup>)  $n_r$  = total number of the point data.

## 2). Nighttime Illumination - Crime Relationship

The strength of illumination is inferred from the KD. The kernel density map was reclassified into three classes of nighttime illumination intensity (poorly, moderately, and highly illuminated areas). To examine the relationship between illumination and crime spots, the crime inventory data was overlayed on the illumination map and the intercept was identified and recorded in binary format. Where there is an agreement (crime spot falls in the well-illuminated area), it is labeled 1; but there is disagreement (fall in the poorly

illuminated area), it is labeled 0. Finally, the relationship between crime and nighttime illumination was determined using the percentage of agreement statistics (Benchoufi et al., 2020) - Equation 6. The total number of locations in agreement divided by the total number of crime spots is expressed in percentage.

$$\frac{n}{N} \times 100 \quad (6)$$

where  $n$  = number of crime zones in each class,  $N$  = the total number of crime zones

## IV. RESULTS AND DISCUSSION

### A. Pattern Analysis

Figure 3 is the general layout (building and road network) of the campus including the distribution of streetlights, represented as points feature on the map (Figure 3a). The road network which comprises the university road that links the University of Ilorin to the Tanke community, Mohammed Road, Afolabi Road, and Oludaramola Road provides access to various faculties and facilities within the campus.

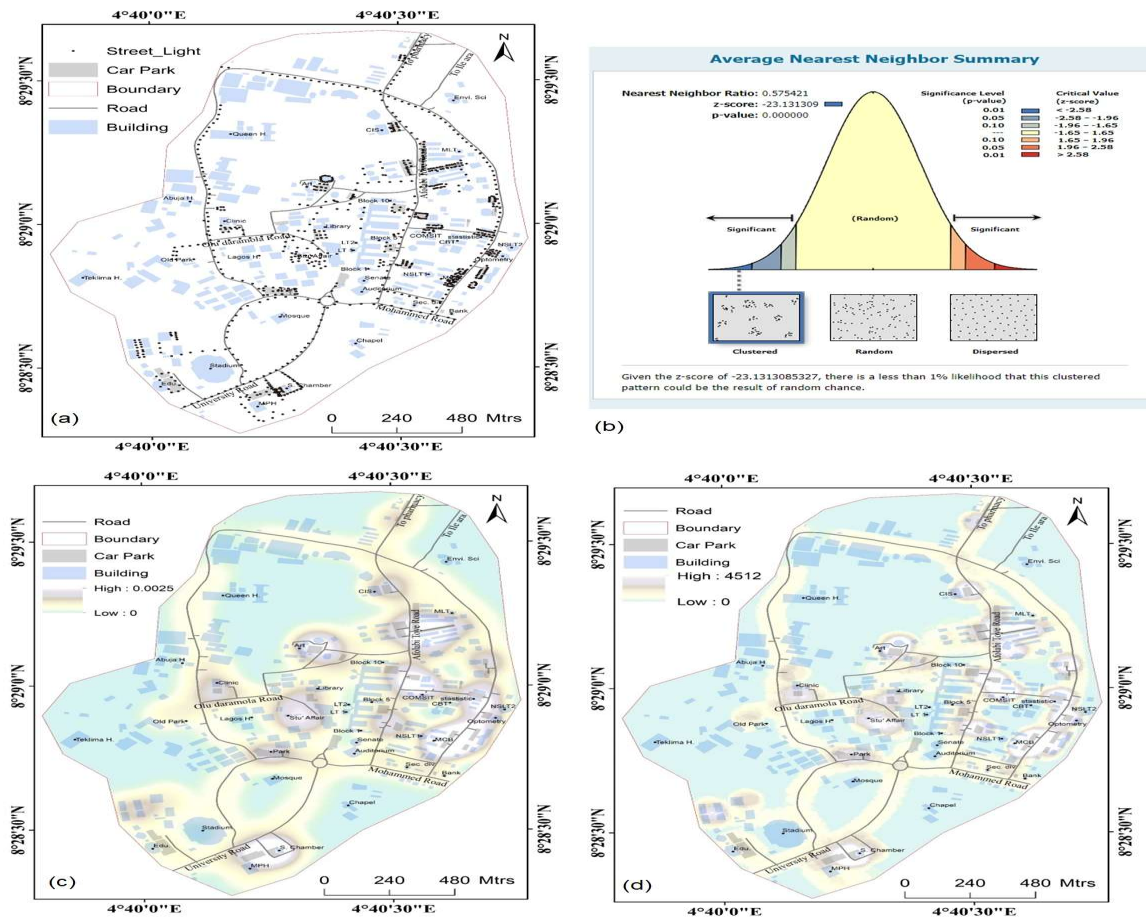


Figure 3: General layout (a) man-made features (b) ANN analysis, (c) KD analysis, and (d) PD analysis.

A total of 810 streetlights were mapped, most of which are located within parking areas and along roadsides (Figure 3a). 30 Nos of the streetlights are solar powered while the remaining 780 derive energy from the national grid. The height of the streetlight poles varies between 3 m and 6.5 m, with the latter majorly located along the median (with dual bulbs) and roadsides. The ANN report (Figure 3b) provides information about the spread and distribution of the streetlights. The result indicates a clustered pattern with an ANN value of 0.575 (Z-score -23.131) and p-value of 0.000, meaning that the streetlights are not evenly distributed. Areas with poor presence of streetlights include Teklima Hostel, Queen Hostel, Faculty Environmental Science, the rear side of the Faculty of CIS, the chapel, and the mosque area.

KD map (Figure 3c) shows areas with high density and areas with low density. The areas with high density are areas with more streetlights while areas with low density are those with no or insufficient streetlights. Kernel density map density ranges from high to low using stretched colour from anti-flash white colour to Alice blue colour. The high-density area is represented with anti- flash white colour and the area with low density is represented with an Alice blue colour. The density represents the illumination of the area as a function of the number of streetlights available in the area. The more and closer the streetlight, the higher the density, and vice versa. COMISIT, Department of Optometry, the University Multipurpose Hall (MPH), the Senate Chamber, the school park, the Microbiology Department, the Faculty of Communication and

Information Science (CIS), Student's Affair Unit area have more streetlights, compared to Teklima Hostel, Queen Hostel area, Chapel area, Faculty of Environmental Science with fewer or no streetlights. Also, the PD map (Figure 3d) shows a similar pattern to the KD map. However, a PD representation would depict all cells as having the same density, even though that's not accurate. In contrast, a kernel density approach would indicate that areas farther from data points have lower values, reflecting their distance from the observed data within the search area (Shuo et al., 2021). This attribute makes the KD more suitable as a representation of illumination intensity.

#### B. Nighttime illumination and crime

Illumination intensity map (Figure 4a) indicating varying nighttime light intensities - high, moderate, and low depicted on the map as Arctic white colour, grey (10%), and grey (30%), respectively. Locations such as the Student's Affairs Park, Microbiology Department Park, Senate Chamber Park, COMSIT, and Optometry Department fall in this category. The moderately illuminated areas are mostly along the roads, particularly Mohammed, Afolabi, and Oludaramola roads. Other areas of the moderate class are the Faculty of Education, school park, Works, Blocks 1 to 9 park, Faculty of Communication and Information Science, and MLT. The poorly illuminated areas are Teklima Hostel, mosque, Queen Hostel, Abuja Hostel, chapel area, and Faculty of Environmental Science.

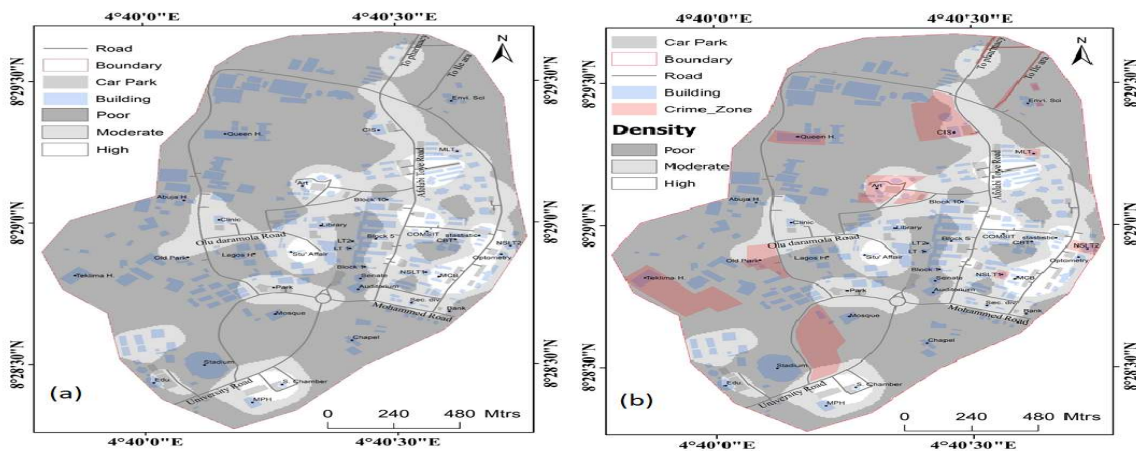


Figure 4: Nighttime illumination (a) illumination intensity and (b) relationship with crime

The overlay of nighttime illumination intensity and historical crime spot (in red polygon) is shown in Figure 4b. Visual observation revealed that nearly all the red spots fall within poorly illuminated areas except the location around the faculty of Art. Locations identified with moderate illumination mostly around major lecture theatres – MLT, NSLT1, and NSLT2 also have their share of reported crime incidents. Random interview of students some students reveals that late-night activities (social and academic) usually occur. From the interview, it was also gathered that phone and laptop snatching, sexual assault, and robbery are common types of threats. Table 2 presents the number and percentage of reported crimes in the respective illumination class. Within the poorly illuminated areas, 9 (69.23%) incidents were reported,

3 (23.08%) in the moderate areas, and only 1 (7.69%) in the high illumination area. The result has shown that most of the reported crimes occurred under the cover of darkness.

Table 2 Crime-illumination statistics

S/N	Illumination Classes	No. of crime reported	Percentage (%)
1	Poor	9	69.23
2	Moderate	3	23.08
3	High	1	7.69

The findings from this investigation present significant implications for both safety and crime prevention strategies. The fact that about 70% of reported crimes occurred in poorly illuminated areas highlights a crucial link between lighting and safety, suggesting that inadequate illumination creates environments conducive to criminal activity. This study aligns with Zhou et al. (2019), who found a strong correlation between nightlight gradients and street robbery in Cincinnati, and with Peng et al. (2022), who reported a 1% increase in arrest rates corresponding with increased nighttime illumination in Chinese cities. Similarly, MacDonald (2015) and Romice et al. (2017) emphasized how modifications in the built environment, particularly lighting, can significantly impact crime prevalence. The correlation between poorly lit areas and crime underscores the vulnerability of individuals in these spaces. Insufficient lighting can embolden potential offenders by providing cover, thereby increasing the risk for students and staff who traverse these areas at night. Given that most streetlights are powered by the public electricity supply, the instability of this service exacerbates the issue. Frequent outages lead to darkened paths, particularly during peak hours for social and academic activities. This instability not only contributes to crime but can also deter students from engaging in nighttime activities, limiting their social and academic opportunities.

Interestingly, a few incidents occurred in moderately or well-lit areas such as around the Faculty of Arts. This suggests that while lighting is a significant factor, it may not be the sole determinant of crime. As noted by Fisher and Sloan (2022), other factors such as student behaviour patterns, absence of security personnel, and time of activity also play a role. While previous studies have largely focused on urban centres or Western settings, this study extends the application of lighting-crime relationship models to a Nigerian university campus, supporting the observations of Badiora (2017) and Ekpoh et al. (2020) that physical security infrastructure, such as lighting, is vital in managing rising campus crime levels.

The small proportion of solar-powered streetlights (only 30 out of 810) suggests a significant opportunity for investment in renewable energy solutions. Expanding the number of solar-powered lights could provide a more reliable source of illumination that is less susceptible to the fluctuations of public power supply. This would enhance safety, especially during times of power outages, and promote a more secure nighttime environment. These findings call for a re-evaluation of campus security policies. University administration should prioritize improved nighttime lighting as a crime prevention measure. This might involve increasing the number of streetlights, especially in high-risk areas, and considering smart lighting solutions that can adapt to usage patterns. Also, involving students in discussions about nighttime safety and lighting can foster a sense of community responsibility. Awareness campaigns could encourage reporting of dark areas, contributing to a more proactive approach to safety. Furthermore, ongoing research to monitor crime rates to lighting improvements would be beneficial. Implementing a system to regularly assess crime incidents alongside illumination levels can help refine strategies and ensure resources are effectively allocated. The integration of

GIS-based techniques like Kernel Density and ANN offers a methodological advancement in campus safety assessment, consistent with recent calls in spatial criminology (Aumüller et al., 2020; Shuo et al., 2021) for more data-driven, location-specific approaches to crime prevention.

## V. CONCLUSION

Nighttime lighting not only reflects social and academic activities but also highlights the characteristics of the campus environment. A vibrant nighttime atmosphere is crucial for fostering students' socioeconomic and intellectual growth. Consequently, ensuring adequate lighting can help reduce crime and other social issues associated with nighttime activities, thereby enhancing the safety of individuals and property. This study investigated the relationship between nighttime illumination and crime at the University of Ilorin by analysing streetlight illumination using GIS techniques. Our findings indicated that most nighttime crimes occurred in dark areas. We also examined the overlap between crime hotspots and lighting intensity, measuring the percentage of correlation. Approximately 70% of reported crimes took place in poorly lit locations. Therefore, improving nighttime lighting is essential for enhancing security measures and reducing crime rates. The findings of this study will be useful for the University management and the security unit in planning for improving nighttime visibility, surveillance, asset inventory, and management. It will also guide the university community, especially students, on crime hot spots to be avoided.

## AUTHOR CONTRIBUTIONS

M.O. Idrees: conceived and managed the project, designed the research, processed data, edited and approved the final draft; M.O. Abisodun: carried out field data collection, processing, prepared the figures and tables; R.W. Mayowa: co-supervision, assisted with research design, analysis, and report review; L. Ajibade: provided crime spot data, edited the draft manuscript.

## ACKNOWLEDGEMENT

The authors wish to extend their sincere gratitude to the Dean of Students' Affairs University of Ilorin for providing data on crime spots and the Safety and Security for providing information on crime incidences.

## REFERENCES

- Aumüller, M., Bernhardsson, E., & Faithfull, A. (2020). ANN-Benchmarks: A benchmarking tool for approximate nearest neighbor algorithms. *Information Systems*, 87, 101374. <https://doi.org/10.1016/j.is.2019.02.006>
- Badiora, A. I. (2017). Patterns of crime on campuses: a spatial analysis of crime and concerns for safety at a Nigerian university. *Acta Criminologica: African Journal of Criminology & Victimology*, 30(3), 180-200.
- Balogun, N. A., Abdulrahman, M. D., & Aka, K. (2024). Exploring the prevalence of internet crimes among undergraduate students in a Nigerian University: A case study

of the University of Ilorin. *Nigerian Journal of Technology*, 43(1), 71-79.

**Belsky, J. (2013).** Differential susceptibility to environmental influences. *International Journal of Child Care and Education Policy*, 7, 15-31. <https://doi.org/10.1007/2288-6729-7-2-15>

**Benchoufi, M., Matzner-Lober, E., Molinari, N., Jannot, A. S., & Soyer, P. (2020).** Interobserver agreement issues in radiology. *Diagnostic and interventional imaging*, 101(10), 639-641. <https://doi.org/10.1016/j.diii.2020.09.001>

**Boots, B. N., & Getls, A. (2020).** Point pattern analysis. Regional Research Institute, West Virginia University, Bouchard Jr, T. J., & McGue, M. (2003). Genetic and environmental influences on human psychological differences. *Journal of Neurobiology*, 54(1), 4-45. <https://doi.org/10.1002/neu.10160>

**Chatterton, P., & Hollands, R. (2002).** *Theorising urban playscapes: Producing, regulating and consuming youthful nightlife city spaces*. *Urban Studies*, 39(1), 95-116. <https://doi.org/10.1080/00420980220099096>

**Cohen, L. E., & Felson, M. (1979).** *Social change and crime rate trends: A routine activity approach*. *American Sociological Review*, 44(4), 588-608.

**Duvvury, N., Callan, A., Carney, P., & Raghavendra, S. (2013).** Intimate partner violence: Economic costs and implications for growth and development. <https://hdl.handle.net/20.500.14041/3417>

**Ekpoh, U. I., Edet, A. O., & Ukpog, N. N. (2020).** Security challenges in Universities: Implications for safe school environment. *Journal of Educational and Social Research*, 10(6),

**Fan, Y., Chen, M., Chen, W., & Ke, J. (2024).** Welcome to the Night: Nighttime Amenities, Travel to Consume, and Urban Economic Spillover. *Travel to Consume, and Urban Economic Spillover*. <https://dx.doi.org/10.2139/ssrn.4990817>

**Fisher, B. S., & Sloan III, J. J. (2022).** *Campus Crime: Legal, Social and Policy Perspectives*. Charles C Thomas Publisher Ltd, Illinois, USA. Fourth Edition.

**Igbinedion, S. O., & Ebomoyi, I. (2017).** Socio-economic determinants of crime: Further evidence from Nigeria. *Annals of the University of Petroșani, Economics*, 17(1), 101-114.

**Kamalov, F. (2020).** Kernel density estimation-based sampling for imbalanced class distribution. *Information Sciences*, 512, 1192-1201. <https://doi.org/10.1016/j.ins.2019.10.017>

**Kanthi, M., & Dilli, R. (2023).** Smart streetlight system using mobile applications: secured fault detection and diagnosis with optimal powers. *Wireless Networks*, 29(5), 2015-2028. <https://doi.org/10.1007/s11276-023-03278-9>

**MacDonald, J. (2015).** Community design and crime: the impact of housing and the built environment. *Crime and justice*, 44(1), 333-383. <https://doi.org/10.1086/681558>

**Ojo, A., & Ojewale, O. (2018).** Urban crime in Nigeria: trends, costs, and policy considerations. *Project Report*. ICF International, London. <https://repository.lincoln.ac.uk/ndownloader/files/42844387>

**Peng, C., Sun, W., & Zhang, X. (2022).** Crime under the light? Examining the effects of nighttime lighting on crime in China. *Land*, 11(12), 2305. <https://doi.org/10.3390/land11122305>

**Ramello, R. (2023).** *The impact of night-time economy districts on violence and perception of safety at night* (Doctoral dissertation, Nottingham Trent University). <https://irep.ntu.ac.uk/id/print/51155>

**Romice, O., Thwaites, K., Porta, S., Greaves, M., Barbour, G., & Pasino, P. (2017).** Urban design and quality of life. *Handbook of environmental psychology and quality of life research*, 241-273. [https://doi.org/10.1007/978-3-319-31416-7\\_14](https://doi.org/10.1007/978-3-319-31416-7_14)

**Sanchi, I. D., Adamu, N., Ekenna, N. E., Simon, S. V., & Alhassan, Y. J. (2022).** The Strengths, Weaknesses, and Prospects of University Education in Nigeria. A Critical Review. *Global Educational Research Journal*, 10(2): Pp, 011-022. ISSN-2360-7963

**Sanidad-Leones, C. V. (2006).** The current situation of crime associated with urbanization: problems experienced and countermeasures initiated in the Philippines. *Resource Material Series*, 68, 133-150.

**Shuo, Z., Jingyu, Z., Zhengxiang, Z., & Jianjun, Z. (2021).** Identifying the density of grassland fire points with kernel density estimation based on spatial distribution characteristics. *Open Geosciences*, 13(1), 796-806. <https://doi.org/10.1515/geo-2020-0265>

**Suleiman, Y., Adeniyi, S. T., Kamal, O., Oluwaseun, L. S., & Abiodun, O. M. (2022).** An Assessment of Students' Enrolment Rate In University Of Ilorin, Nigeria from 2019-2021: Implications for Management. *Journal of Educational Leadership in Action*, 8(2), 4.

**UNODC (2021).** Comprehensive strategies for crime prevention towards social and economic development. 14th United Nations Congress on Crime Prevention and Criminal Justice, Kyoto, Japan, 7 – 12 March, 2021

**Vovk, V. (2021).** Testing randomness online. *Statistical Science*, 36(4), 595-611. <https://doi.org/10.1214/20-STS817>

**Wang, W., Liu, L., & Yang, Y. (2022).** Spatial matching analysis and development strategies of county night-time economy: a case of Anning county, Yunnan Province. *Sustainability*, 14(9), 4891. <https://doi.org/10.3390/su14094891>

**Zhou, H., Liu, L., Lan, M., Yang, B., & Wang, Z. (2019).** Assessing the impact of nightlight gradients on street robbery and burglary in Cincinnati of Ohio State, USA. *Remote Sensing*, 11(17), 1958. <https://doi.org/10.3390/rs11171958>