WJARR

World Journal of
**Advanced
Research and
Reviews**

World Journal Series
INDIA

(RESEARCH ARTICLE)

Check for updates

Leveraging Geographic Information System (GIS) for proactive campus security: A spatiotemporal analysis of crime hotspots at Obafemi Awolowo University, Nigeria

Caleb Olutayo OLUWADARE and John Adeyemi EYINADE *

Department of Surveying and Geoinformatics, Faculty of Environmental Design and Management, Obafemi Awolowo University, Ile-Ife, Nigeria.

Abstract

Ensuring campus security is paramount for higher education institutions, particularly in regions like Nigeria where pervasive insecurity necessitates a shift from reactive to proactive safety measures. This study addresses the critical gap in data-driven campus security by employing Geographic Information System (GIS) methodologies to analyze crime patterns at Obafemi Awolowo University (OAU) from 2017 to 2022. Reported crime data, acquired from the OAU security department, revealed annual crime rates per 1,000 inhabitants of 3.62 (2017), 3.94 (2018), 5.11 (2019), 1.4 (2020), 3.23 (2021), and 4.62 (2022). Theft constituted the majority of reported incidents, predominantly in academic areas and halls of residence. Spatial autocorrelation analysis using Global Moran's I confirmed significant positive clustering of crime incidents across the campus (p < 0.05 for all distance bands), indicating that crime is not random. Hotspot analysis (Getis-Ord Gi*) identified critical high-crime areas including Fajuyi Hall, Awolowo Hall, Post Graduate Hall, Oduduwa Lecture Theater, Admin Extension, Sport Center, and the Banking Area, while the Maintenance area was identified as a cool spot. These findings underscore the effectiveness of GIS in pinpointing specific vulnerabilities, enabling university management to implement targeted, evidence-based interventions for enhanced security. The study advocates for a proactive, spatially-informed approach to campus security, offering a replicable framework for similar institutions facing evolving security challenge

Keywords: Geographic Information System (GIS); Crime Hotspots; Campus Security; Spatial Analysis; Crime Prevention; University Safety

1. Introduction

Ensuring a secure and conducive environment is paramount for the effective functioning and long-term sustainability of higher education institutions globally [1, 2, 3]. Beyond merely facilitating academic pursuits, campus safety is intrinsically linked to student recruitment and retention, faculty productivity, research integrity, and the overall reputation of the university within the global academic landscape [4]. Universities, characterized by their open access, high population density, and diverse socio-economic profiles, present unique security challenges [5, 6]. These range from common opportunistic crimes, such as theft and assault, to more organized criminal activities and even the pervasive threat of external security breaches, including terrorism and abductions, which can have catastrophic consequences [5].

In Nigeria, the imperative for robust campus security is particularly pronounced, amplified by a broader national landscape grappling with multifaceted security challenges [7, 8, 9]. Recent years have underscored the severe vulnerabilities within the educational sector, exemplified by incidents such as the suspension of academic operations at Veritas University due to credible terror threats, and the tragic kidnapping of over 200 schoolgirls from the Government

* Corresponding author: John Adeyemi Eyinade.

Girls Secondary School in Chibok, Borno State [10, 11, 7]. These events not only highlight the susceptibility of educational institutions to external aggressions but also underscore the systemic inadequacy of existing security protocols. Obafemi Awolowo University (OAU), a leading institution in Nigeria, has historically and presently faced its share of crime and instability since its establishment. This includes serious historical incidents and persistent challenges such as the recurrent theft of personal items from student residential halls and academic areas, alongside various instances of physical violence [12, 13, 14].

A critical examination of existing campus security measures, both at OAU and across many Nigerian universities, reveals a predominantly reactive paradigm [13]. Security interventions, such as the deployment of temporary checkpoints at the entrance of affected halls, are frequently initiated only *after* a crime has been reported. While seemingly addressing immediate concerns, these reactive strategies are inherently limited and often ineffective; they are temporary, lack sustained presence, and rarely facilitate the apprehension of offenders or proactively deter future incidents [14]. This reactive stance, as evidenced by the broader response to security breaches in the country, signifies a profound systemic weakness. Crucially, this highlights a significant research gap: the absence of systematic, evidence-based, and spatially-informed approaches to crime analysis that can transition campus security from a reactive to a truly preventive model [15, 10]. Traditional crime reporting often lacks the granular spatial detail necessary to understand crime patterns, cluster formations, and underlying environmental factors, thus hindering the development of targeted and effective interventions [8, 9].

To bridge this gap, a deeper understanding of crime dynamics rooted in criminological theories is essential [16]. Security, in its fundamental essence, refers to the deliberate actions undertaken to safeguard individuals, physical structures, or even sovereign nations from various forms of harm, threats, or criminal activities [17]. Crime itself, broadly defined by [18] as behavior involving the obtaining of resources from others via force, fraud, or stealth, is universally considered a public wrong. Understanding the spatial and temporal distribution of crime is central to developing effective prevention strategies, which is where environmental criminology offers crucial insights [19, 17]. Two influential theories from environmental criminology are particularly pertinent to understanding the spatial dynamics of campus crime. Routine Activity Theory, for instance, posits that a criminal event arises from the convergence of a motivated offender, a suitable target, and the absence of a capable guardian in time and space [20, 21]. On a university campus, this framework elucidates the prevalence of opportunistic crimes [22], such as theft, where valuable student possessions represent available targets in areas potentially lacking overt security presence [19]. Complementing this, Crime Pattern Theory further illuminates how criminal activity is not randomly dispersed but rather follows predictable patterns influenced by the daily routines and activity spaces of both offenders and victims [20]. This theory highlights the significance of "awareness spaces," where offenders operate within familiar nodes (e.g., academic buildings, residential halls), paths (common routes), and edges (transitional zones) within the campus environment [20, 22]. Consequently, these areas can become predictable loci for criminal acts, leading to the formation of crime "hotspots." Together, these theoretical frameworks provide a robust foundation for comprehending why certain areas within a university campus might disproportionately experience higher crime rates or specific types of offenses, thereby moving beyond mere incident reporting to a deeper, environmentally informed analysis of crime causation [23].

The effective visualization and analytical interpretation of geospatial information are thus paramount for modern crime prevention and intervention [24]. Geographic Information Systems (GIS) serve as highly sophisticated computational tools indispensable for the creation, rigorous analysis, and precise identification of patterns embedded within geographic data [25, 24]. By enabling the comprehensive examination and analysis of diverse data layers within a mapped context [26], GIS profoundly enhances our understanding of complex phenomena and facilitates more informed decision-making [24, 27]. Its inherent power lies in its capacity to clarify the precise spatial relationships between various elements, simplify otherwise complex analyses, and reveal clear, actionable insights, given that information cannot be fully comprehended unless it is spatially contextualized [28]. In the specialized domain of criminology, GIS has become an indispensable asset. Its applications range from fundamental crime mapping [28, 24, 29], which visually represents individual crime incidents and their spatial distribution, to advanced hotspot analysis [24]. Techniques such as Global Moran's I and Getis-Ord Gi* are employed within GIS environments to statistically identify and validate clusters of criminal activity (hotspots) and areas of significantly lower crime (cool spots) [30,26]. This statistical validation is critical, ensuring that identified spatial concentrations are not merely random occurrences but statistically significant patterns. The ability to precisely delineate these concentrations of criminal activity is vital for the strategic allocation of security resources and the implementation of targeted policing efforts [31, 32].

This study, therefore, aims to directly address the critical gap in proactive campus security by leveraging Geographic Information System (GIS) technology to revolutionize the understanding and management of campus security at Obafemi Awolowo University. Utilizing reported crime data from 2017 to 2022, this research will systematically

determine annual crime rates, analyze the spatiotemporal distribution of various crime types, and rigorously identify persistent crime hotspots and cool spots across the campus environment. By transforming raw crime data into actionable geospatial intelligence, this study will offer precise, evidence-based insights that can inform the strategic allocation of security resources, guide the implementation of targeted preventive measures, and ultimately foster a safer and more conducive learning and living environment for the entire university community. The findings will not only be instrumental for OAU's specific context but will also provide a replicable methodology and valuable lessons for other higher education institutions grappling with similar security challenges in Nigeria and beyond.

2. Methods

This section delineates the comprehensive methodological framework employed to achieve the objectives of this study. It outlines the research design, describes the geographical characteristics of the study area, details the processes of data acquisition and preparation, and elaborates on the spatial analytical techniques utilized to identify crime patterns and hotspots on the Obafemi Awolowo University campus. The approach adopted is primarily quantitative, leveraging Geographic Information System (GIS) tools for spatial data processing and analysis.

2.1. Study Area

This study was conducted within the central campus and student residential areas of Obafemi Awolowo University (OAU), a prominent federal university located in Ile-Ife, Osun State, Nigeria. OAU is a large, open-access institution with a significant population of students, faculty, and administrative staff, making its security profile particularly relevant for understanding campus safety dynamics in the Nigerian context. The defined study area specifically encompasses the core academic zone, comprising various lecture theaters, faculty offices, and administrative facilities, alongside the student residential zone, which includes nine distinct halls of residence. These areas represent the primary loci of daily activities for the majority of the university community, thereby making them critical for crime analysis. The geographical representation of the study area was established by digitizing satellite imagery acquired from Google Earth Pro. This digitized map data was subsequently exported in Keyhole Markup Language (KML) format and then seamlessly converted into usable layers within the ArcGIS 10.7.1 software application, serving as the foundational spatial dataset for the research. The geographical context of Obafemi Awolowo University and the specific boundaries of the study area are visually represented in Figure 1.
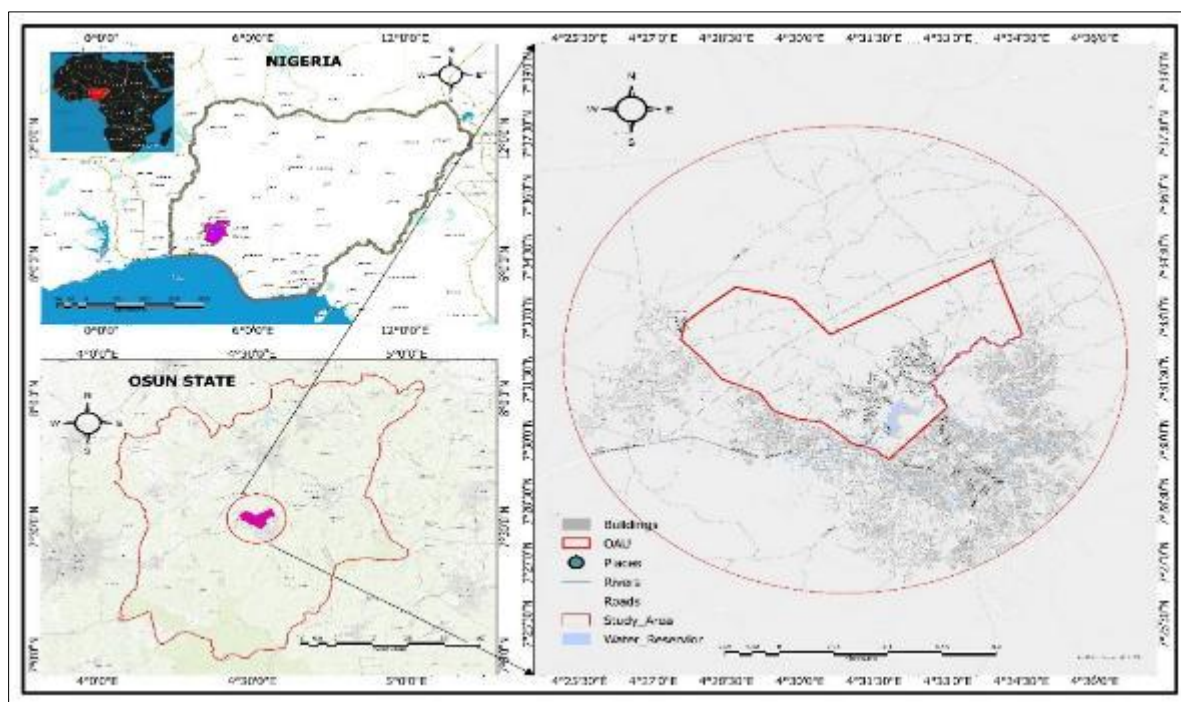

Figure 1 Map of the Study Area (Obafemi Awolowo University Campus)

2.2. Data Acquisition

The primary data for this study comprised reported crime incidents on the Obafemi Awolowo University campus for a six-year period, spanning from 2017 to 2022. This comprehensive crime data, detailing various types of offenses committed and their precise locations, was obtained directly from the security department of OAU. According to information provided by the security department, the collected data was deemed reliable and of high quality for the purpose of this analysis. The specific breakdown of crime types and their occurrences within both the academic area and halls of residence for each year from 2017 to 2022 is presented in Tables 1 through 6. For the calculation of crime rates, the total population of the campus was assumed to be 35,000 inhabitants.

Table 1 Crime data in OAU Campus for year 2017

2017 CRIME RECORD							
Campus Area	**Theft**	**Assault**	**Threat to Life**	**Breaking and entering**	**Rape/Sexual Assault**	**Car breakings**	**Wilful Damage**
Academic Area	40	8	2	2	0	2	1
Halls of Residence	55	10	3	3	1	0	0

Table 2 Crime data in OAU Campus for year 2018

2018 CRIME RECORD							
Campus Area	**Theft**	**Assault**	**Threat to Life**	**Breaking and entering**	**Rape/Sexual Assault**	**Car breakings**	**Wilful Damage**
Academic Area	72	6	0	3	1	0	1
Halls of Residence	38	12	2	3	0	0	0

Table 3 Crime data in OAU Campus for year 2019

2019 CRIME RECORD							
Campus Area	**Theft**	**Assault**	**Threat to Life**	**Breaking and entering**	**Rape/Sexual Assault**	**Car breakings**	**Wilful Damage**
Academic Area	113	3	4	2	2	0	0
Halls of Residence	49	5	0	0	0	0	1

Table 4 Crime data in OAU Campus for year 2020

2020 CRIME RECORD							
Campus Area	**Theft**	**Assault**	**Threat to Life**	**Breaking and entering**	**Rape/Sexual Assault**	**Car breakings**	**Wilful Damage**
Academic Area	30	1	0	1	0	0	0
Halls of Residence	12	4	0	0	0	0	1

Table 5 Crime data in OAU Campus for year 2021

2021 CRIME RECORD							
Campus Area	Theft	Assault	Threat to Life	Breaking and entering	Rape/Sexual Assault	Car breakings	Wilful Damage
Academic Area	64	9	1	4	1	0	0
Halls of Residence	30	0	0	2	0	0	2

Table 6 Crime data in OAU Campus for year 2022

2022 CRIME RECORD							
Campus Area	Theft	Assault	Threat to Life	Breaking and entering	Rape/Sexual Assault	Car breakings	Wilful Damage
Academic Area	101	14	4	2	0	1	2
Halls of Residence	27	8	1	2	0	0	0

2.3. Data Analysis

The collected crime data was subjected to rigorous spatial analysis using Geographic Information System (GIS) methodologies, primarily within the ArcGIS 10.7.1 software environment. The analytical workflow commenced with the preparation of the crime incident data. Initially, the data, received in an Excel spreadsheet format, was saved as a Comma Separated Values (CSV) file. This CSV file was then imported into ArcMap and converted into a georeferenced shapefile. To ensure accurate spatial measurements and analysis, the coordinate system of the crime data was transformed from a geographic coordinate system to a Universal Transverse Mercator (UTM) coordinate system by using the projection tool in the ArcGIS ArcToolbox.

Two principal spatial statistical techniques were employed to achieve the study's objectives

2.3.1. Spatial Autocorrelation (Global Moran's I)

This statistical measure was utilized to assess the degree to which the values of a variable at one location are related to the values of the same variable at nearby locations. Global Moran's I quantifies the overall spatial autocorrelation within the dataset, indicating whether crime incidents are clustered (positive spatial autocorrelation), dispersed (negative spatial autocorrelation), or randomly distributed (zero spatial autocorrelation). The index value ranges from -1 to 1, with values closer to 1 indicating stronger clustering and a value of 0 indicating no spatial autocorrelation. The Global Moran's I tool in ArcGIS was used to calculate the Moran's I index value, along with a z-score and p-value, to determine the statistical significance of the observed spatial patterns across various distance bands. The results of the Global Moran's I statistical analysis are detailed in Table 7.

2.3.2. Hotspot Analysis (Getis-Ord Gi*)

To identify statistically significant spatial clusters of high crime occurrences (hotspots) and low crime occurrences (cool spots), the Getis-Ord Gi* tool was employed. This method goes beyond simply mapping crime density by statistically determining whether the clustering of high or low values is more pronounced than would be expected by random chance. The output of this analysis clearly delineates "danger zones" (hotspots) requiring critical security attention and "peaceful zones" (cool spots) within the study area. The crime event map, generated using the "collect event tool," provided an initial visualization of crime concentration, followed by the Hotspot and Cold spot map analysis, depicted in Figure 5.

3. Results

This section presents the findings from the spatial and temporal analysis of crime data collected from Obafemi Awolowo University (OAU) between 2017 and 2022. The results encompass crime frequencies by type and location, overall campus crime rates, and the identification of spatial crime patterns, including hotspots and cool spots.

3.1. Crime Frequencies and Trends

The distribution of different crime types across the academic area and student residential halls on the OAU campus is illustrated in Figures 2 and 3, respectively. A consistent observation across both campus zones is that theft constitutes the highest proportion of reported incidents. Furthermore, the academic area generally recorded a higher overall frequency of crimes when compared to the halls of residence throughout the six-year study period.
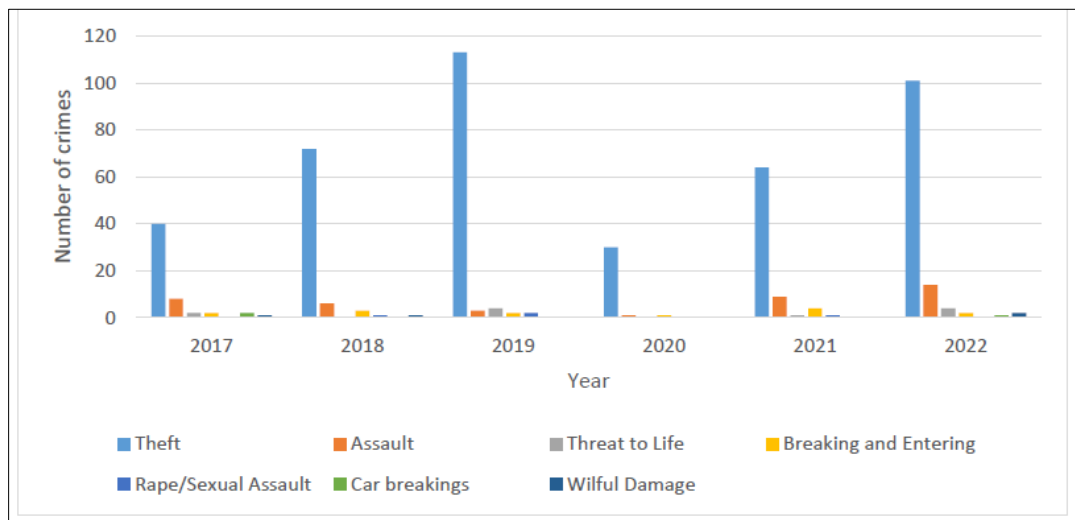

Figure 2 Annual Crime Frequency by Type in Academic Area (2017-2022)
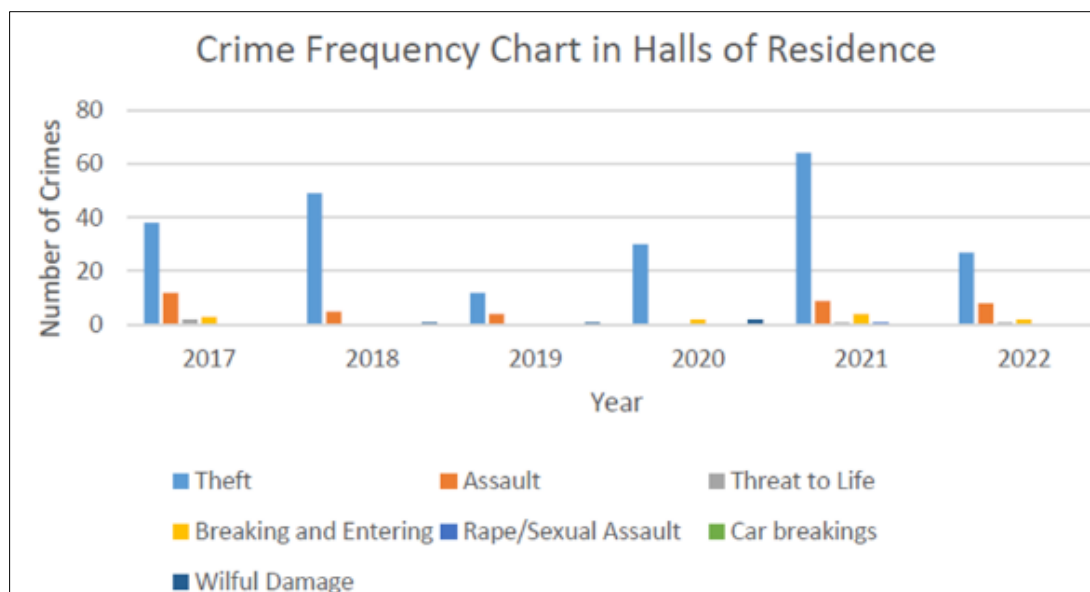

Figure 3 Annual Crime Frequency by Type in Halls of Residence (2017-2022)

The overall crime rate for the OAU campus was determined using the standardized formula

$$\text{Crime Rate} = (\text{Number of reported crimes/ Total population}) \times 1000$$

With the estimated campus population being 35,000 inhabitants, the calculated crime rates per 1,000 inhabitants for the years 2017 to 2022 are as follows: 3.62 (2017), 3.94 (2018), 5.11 (2019), 1.4 (2020), 3.23 (2021), and 4.62 (2022). The temporal trend of these annual crime rates across the study period is visualized in Figure 4. The year 2019 recorded the highest crime rate within the six-year span, whereas 2020 exhibited a notable decrease, registering the lowest crime rate. This significant reduction in 2020 is directly attributable to the prolonged shutdown of the university campus due to the global COVID-19 pandemic, which resulted in a substantial decrease in the on-campus population and, consequently, reduced opportunities for crime.
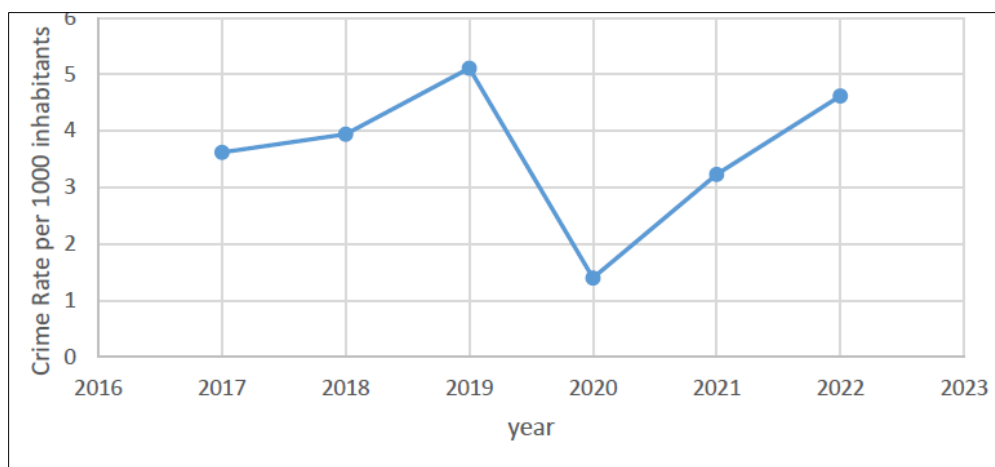

Figure 4 Crime Rate Trend in OAU Campus (2017-2022)

3.2. Spatial Patterns of Crime

The spatial distribution and concentration of crime events across the OAU campus are depicted in Figure 5, the crime event map. This visualization reveals that a majority of reported crimes consist of theft of phones in student residential halls and specific lecture theaters within the academic area. Furthermore, a considerable number of incidents, particularly forceful entry into parked cars and theft of money from vehicles, were reported in the banking area region. Incidents involving physical violence were frequently reported in the Student Union Building (SUB) area and the central market near ETF hall of residence.
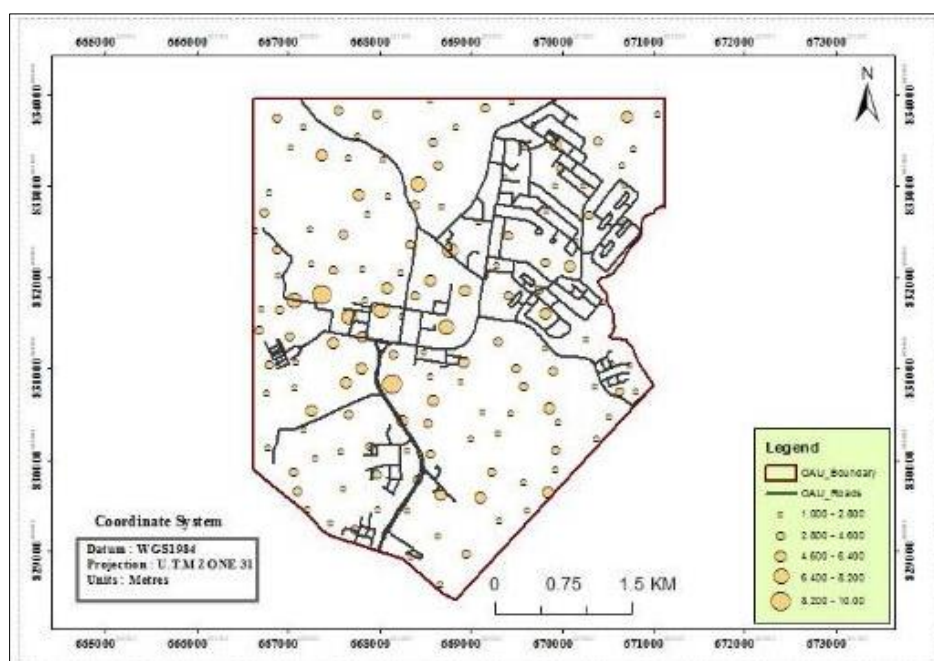

Figure 5 Crime Event Distribution (Integrative Analysis) Map of the Study Area

The Global Moran's I analysis was conducted to assess the overall spatial autocorrelation of crime incidents across the campus, with detailed statistical results presented in Table 7. The analysis indicated positive spatial autocorrelation across all examined distance bands, with all p-values being less than 0.05. This statistically significant finding confirms that the clustering of crime hotspots and cool spots is not attributable to random chance. The results also suggest that crime hotspots and cool spots frequently coexist in close proximity. Specifically, the clustering of crime hotspots was more pronounced at shorter distances, while the clustering of cool spots became more evident at longer distances.

Table 7 Global Moran's I Hotspot Analysis statistical result

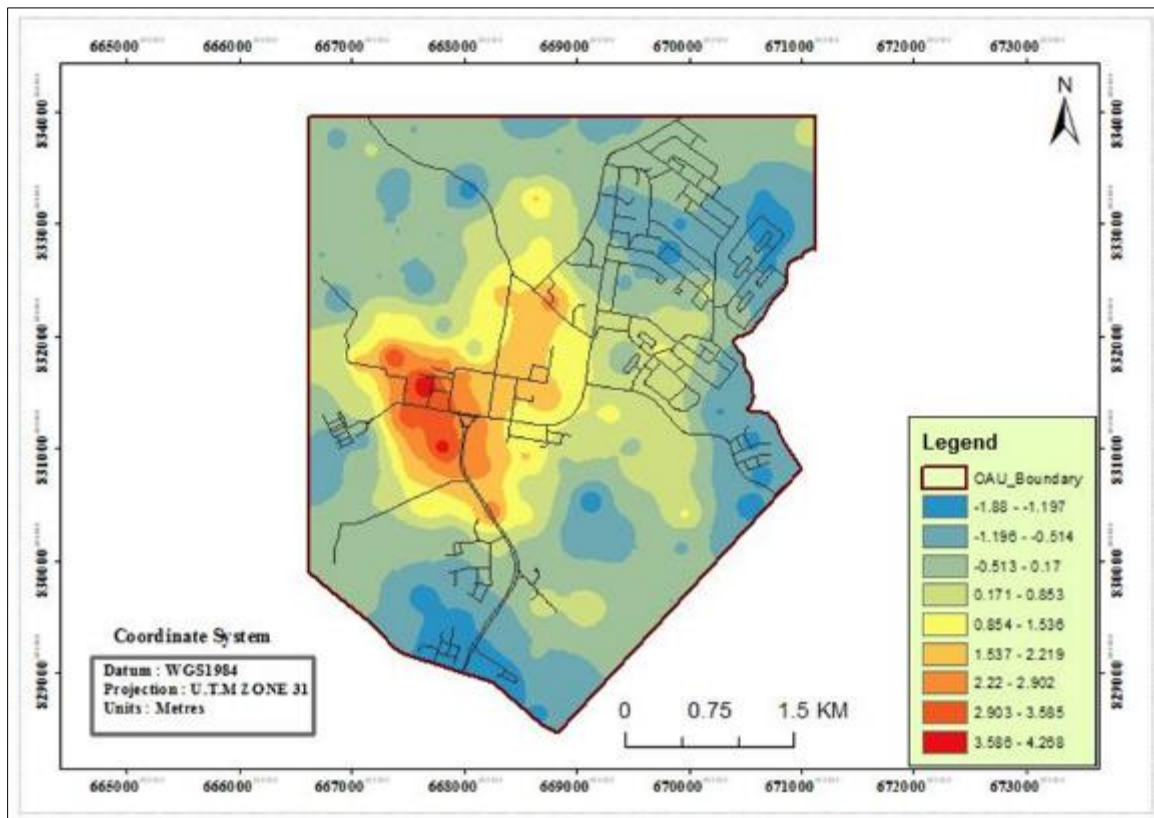| Distance	Moran's index	Expected index	variance	z-score	P value
445.00	0.159371	-0.006993	0.004372	2.516015	0.011869
583.46	0.111567	-0.006993	0.002336	2.453005	0.014167
721.91	0.126348	-0.006993	0.001494	3.449896	0.000561
860.37	0.119289	-0.006993	0.001033	3.928186	0.000086
998.82	0.099553	-0.006993	0.000729	3.946652	0.000079
1137.28	0.078796	-0.006993	0.000562	3.617499	0.000297
1275.74	0.078242	-0.006993	0.000437	4.077468	0.000046
1414.19	0.071951	-0.006993	0.000348	4.229806	0.000023
1552.65	0.057735	-0.006993	0.000283	3.845881	0.000120
1691.11	0.054276	-0.006993	0.000232	4.023134	0.000057

3.3. Crime Hotspots and Cool Spots

Figure 6 Hotspot and Cold Spot Map Analysis of the Study Area

The results of the Hotspot and Cold spot map analysis, derived from the Getis-Ord Gi* statistic, are presented in Figure 6. This map visually distinguishes areas of high crime concentration (hotspots) from areas of low crime concentration (cool spots). The blue color gradient on the map indicates cool spots, representing "peace zones" where crime rates are low, with deeper blue signifying cooler (safer) areas. Conversely, the red color gradient signifies hotspots or "danger zones," where crime rates are higher, with deeper red indicating a more intense concentration of crime.

The specific geographic coordinates and names of the identified hotspot and cool spot locations are provided in Tables 8 and 9, respectively. These tables pinpoint critical areas requiring heightened security attention and areas that demonstrate relative safety within the campus environment.

Table 8 Hotspot location

Hotspot Locations	Northings(m)	Easting(m)
Fajuyi hall	831329.459	6670506.913
Awolowo hall	831672.354	667172.366
Post graduate hall	831787.921	667390.827
Oduduwa lecture theater	831411.225	667932.883
Admin extension	831690115	667678.995
Sport center	831009.351	667805.921
Banking area	830944.885	668089.648

Table 9 Cold spot location

Cold spot Location	Northings(m)	Easting(m)
Maintenance	829184.866	667861.644

4. Discussion

The findings of this study provide crucial insights into the spatial and temporal dynamics of crime on the Obafemi Awolowo University campus, offering an evidence-based foundation for transitioning towards a more proactive security management paradigm.

4.1. Interpretation of Crime Frequencies and Trends

The analysis of crime frequencies reveals that theft consistently accounts for the highest proportion of reported incidents in both academic areas and halls of residence. This prevalence aligns strongly with

Routine Activity Theory, which posits that crime occurs when a motivated offender converges with a suitable target in the absence of a capable guardian. On a university campus, personal items like mobile phones and laptops (highly suitable and valuable targets) are frequently left unattended in lecture theaters, libraries, and even student rooms, creating abundant opportunities for opportunistic theft. The higher overall crime frequency observed in academic areas compared to halls of residence could be attributed to the larger number of suitable targets present during active academic hours, combined with a greater influx of non-campus affiliates.

The calculated crime rates for OAU, ranging from 1.4 to 5.11 per 1,000 inhabitants between 2017 and 2022, indicate that the campus generally maintains a relatively low crime rate compared to typical urban environments. However, the fluctuation in these rates, particularly the

peak in 2019 (5.11 per 1,000) and the sharp decline in 2020 (1.4 per 1,000), offers compelling insights. The significant reduction in crime during 2020 directly correlates with the prolonged campus shutdown due to the COVID-19 pandemic. This observation strongly supports the core tenets of Routine Activity Theory; the drastic reduction in the "suitable target" and "motivated offender" populations (as students and staff were largely absent), coupled with

heightened, albeit basic, institutional guardianship, led to a proportional decrease in criminal opportunities and, consequently, crime incidents. Despite the overall low rates, the presence of various crime types and the historical context of insecurity underscore the continuous need for improvement in campus security.

4.2. Interpretation of Spatial Crime Patterns (Hotspots and Cool Spots)

The positive spatial autocorrelation observed across all distance bands, as confirmed by the statistically significant Global Moran's I index, is a critical finding. This indicates that crime incidents on the OAU campus are not randomly distributed but rather cluster in specific locations. This clustering underscores the applicability of Crime Pattern Theory, which suggests that criminal activities concentrate in areas that form part of offenders' and victims' routine awareness spaces, particularly around key "nodes" and "paths" within the campus environment.

The identification of specific crime hotspots further validates this theoretical perspective. Locations such as Fajuyi Hall, Awolowo Hall, Post Graduate Hall, and Oduduwa Lecture Theater are prominent residential and academic "nodes" with high population density and frequent student activity. These areas naturally present a higher convergence of suitable targets (students and their belongings) and potential offenders, leading to increased opportunities for theft and other opportunistic crimes. Similarly, the Banking Area being identified as a hotspot for car break-ins and money theft aligns with its function as a financial "node" where individuals carry valuables, making them attractive targets. The Student Union Building (SUB) area and the central market near ETF Hall, identified for physical violence, represent social and commercial "nodes" with high foot traffic and potential for disputes or conflicts, consistent with crime patterns in urban social hubs. The Sport Center, another hotspot, might attract diverse groups, creating varying levels of guardianship and target suitability.

Conversely, the identification of Maintenance as a cold spot offers insights into preventive environmental design. This area, likely characterized by restricted access, fewer public activities, and perhaps consistent, specialized personnel presence, inherently offers fewer opportunities for crime. The finding that hotspots and cool spots can frequently coexist in close proximity indicates that localized interventions based on spatial analysis are highly feasible and necessary, as safety can vary significantly even within short distances.

4.3. Policy Implications and Recommendations

The findings of this study strongly advocate for a strategic shift from reactive security measures to a proactive, spatially-informed crime prevention framework at Obafemi Awolowo University. By precisely identifying crime hotspots, the university management and security authorities can optimize resource allocation and implement targeted interventions rather than relying on generalized or post-incident responses.

4.3.1. Specific recommendations include

- **Targeted Surveillance and Patrols:** Increase the visibility and frequency of security patrols, both uniformed and plainclothes, specifically within identified hotspots such as the residential halls (Fajuyi, Awolowo, Post Graduate), Oduduwa Lecture Theater, Admin Extension, Sport Center, Banking Area, SUB, and Central Market. These patrols should be data-driven, potentially adjusted for peak crime times.
- **Enhanced Environmental Security:** Implement Crime Prevention Through Environmental Design (CPTED) principles in hotspots. This includes improving lighting in poorly lit areas, installing and maintaining functional Closed-Circuit Television (CCTV) cameras in strategic locations, and ensuring proper maintenance of physical infrastructure that could provide cover for criminal activity.
- **Access Control and Monitoring:** Review and strengthen access control mechanisms, especially for residential halls and academic buildings after hours, to limit unauthorized entry. The observed theft patterns suggest a need for improved internal security within buildings.
- **Community Engagement and Awareness:** Launch targeted awareness campaigns for students and staff on personal safety and property security, particularly emphasizing precautions against phone and car theft in identified vulnerable zones. Encourage immediate reporting of suspicious activities.
- **Data-Driven Decision Making:** Establish a permanent GIS-based crime mapping and analysis unit within the university's security department. This would enable continuous monitoring of crime trends, real-time identification of emerging hotspots, and evaluation of the effectiveness of implemented security measures, fostering a truly adaptive and proactive security system.

4.4. Limitations and Future Research

This study, while robust in its spatial analysis, is subject to certain limitations. It relies exclusively on reported crime data, which may not capture all incidents due to underreporting—a common challenge in crime research. Additionally,

the study period (2017-2022) provides a valuable snapshot, but longer-term data could reveal more subtle evolving patterns. The crime rate calculation used a constant campus population, which may fluctuate throughout the year (e.g., during holidays or semester breaks), potentially affecting the precise annual rates.

Future research could expand upon this study by incorporating additional variables such as socio-economic data of the surrounding communities, environmental factors (e.g., lighting, presence of security personnel, access points, land use), and detailed offender/victim profiles to enrich the understanding of crime causation. Investigating seasonal or daily variations in crime patterns could further refine targeted interventions. Moreover, future studies should aim to evaluate the effectiveness of security measures implemented based on these findings, thereby providing empirical evidence of their impact on campus safety. The development of predictive models using more granular, potentially real-time, crime data would also represent a significant advancement for proactive campus security management.

5. Conclusion

This study employed Geographic Information System (GIS) methodologies to conduct a comprehensive spatial and temporal analysis of crime patterns on the Obafemi Awolowo University (OAU) campus from 2017 to 2022, providing crucial data-driven insights for proactive security management. The research successfully determined the annual crime rates, which were 3.62 (2017), 3.94 (2018), 5.11 (2019), 1.4 (2020), 3.23 (2021), and 4.62 (2022) per 1,000 inhabitants respectively. A significant finding was that 2019 recorded the highest crime rate, while 2020 exhibited the lowest, a reduction directly attributable to the absence of academic activity and subsequent campus closure due to the COVID-19 pandemic.

The analysis revealed that theft constitutes the majority of reported crimes, predominantly occurring in residential halls and specific academic lecture theaters. Critically, the spatial autocorrelation analysis confirmed a statistically significant clustering of crime incidents across the campus, indicating that crime is not randomly distributed but forms discernible hotspots and cool spots. This finding underscores the applicability of environmental criminology theories, particularly Routine Activity Theory and Crime Pattern Theory, in explaining how specific campus environments facilitate criminal opportunities. The precise identification of these crime hotspots – including areas such as Fajuyi Hall, Awolowo Hall, Post Graduate Hall, Oduduwa Lecture Theater, Admin Extension, Sport Center, and the Banking Area – provides an unprecedented level of granularity for security planning. Conversely, the identification of a significant cool spot like the Maintenance area highlights characteristics that may deter criminal activity.

In bridging the identified research gap, this study demonstrates the transformative potential of GIS in moving campus security from a reactive to a highly proactive and evidence-based approach. The detailed crime maps and hotspot analyses generated herein serve as indispensable tools for university management, security authorities, and decision-makers. They enable the strategic allocation of limited resources, allowing for focused attention on high-risk areas through targeted patrols, enhanced surveillance, improved lighting, and specialized awareness campaigns. This proactive framework is vital for mitigating crime effectively and fostering a safer, more conducive learning and living environment.

While this research offers substantial contributions, future studies could further refine these insights by integrating additional socio-economic data, exploring seasonal crime variations, and longitudinally assessing the efficacy of implemented security interventions. Ultimately, this research provides a critical step towards more intelligent and preventative campus security management, not only for Obafemi Awolowo University but also for other higher education institutions confronting similar security challenges in the region and globally.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflicts of interest.

Author Contribution

- Caleb Olutayo OLUWADARE: Conceptualization, Writing- Review and Editing, Supervision.
- John Adeyemi EYINADE: Methodology, Writing- Original draft preparation, Visualization

Funding

The research received no external funding.

References

[1] Lanford, M. (2020). Long Term Sustainability in Global Higher Education Partnerships (pp. 87–93). Springer, Cham. https://doi.org/10.1007/978-3-030-25525-1_9

[2] Carungay, S. M., Lasian, L., Lopez, D. J. D., and Malit, R. M. (2023). A Proposed Framework for Sustainable and Impactful Higher Education Institutions. ACE. https://doi.org/10.22492/issn.2186-5892.2023.22

[3] Serbenyuk, S. (2024). Resilience and sustainability in the activities of a higher education institution. Право і Безпека, 95(4), 32–46. https://doi.org/10.32631/pb.2024.4.03

[4] Chemagosi, M. J. (2024). Student Well-Being in Higher Education Institutions. Advances in Higher Education and Professional Development Book Series, 81–106. https://doi.org/10.4018/979-8-3693-4417-0.ch004

[5] Dong, B. (2023). Research on the Construction of Campus Security System in Colleges and Universities Guided by the Thought of the New Era. Frontiers in Educational Research, 6(11). https://doi.org/10.25236/fer.2023.061124

[6] Ромашкова, О. Н., and Kapterev, A. I. (2023). Analysis of threats and risks of information security at the university. 1(63). https://doi.org/10.25688/2072-9014.2023.63.1.03

[7] Nte, A. D. (2023). School Security and Safety Challenges in Nigeria: Evaluating the Existential Threats of Domestic Terrorism in the North East Region. Seuneubok Lada, 10(2), 42–67. https://doi.org/10.33059/jsnbl.v11i2.8627

[8] Farouk, S., Uppin, C., and George, G. (2024). Enhancing Cybersecurity in Nigeria: A Proposed Risk Management Framework for Universities. 1–8. https://doi.org/10.1109/seb4sdg60871.2024.10629748

[9] Musa, A., Mukhtar, J. I., Adamu, A. D., and Raula, A. D. (2024). An evaluation of the security challenges confronting nigeria. 4(2), 318–325. https://doi.org/10.57233/gujos.v4i2.26

[10] Monguno, A. K., Abdullahi, M. K., and Aji, Y. S. M. (2018). Effects of Boko Haram Insurgency on Public Schools and Responses by Government of Borno State, Nigeria. Developing Country Studies, 8(11), 49–54. https://www.iiste.org/Journals/index.php/DCS/article/view/44984

[11] Flores, R. P. (2021). Ataques violentos hacia la universidad y a la educación. 20, 221–235. https://doi.org/10.17561/RAE.V20.16

[12] Innocent, A. A., Musa, A., and Jacob, O. (2021). Causes, Forms and Consequences of Insecurity on Nigerian Educational System: Implications for Educational Managers. 18, 262–272. https://doi.org/10.47494/MESB.2021.18.881

[13] Adeyemi, B. A., and Ogunleye, S. A. (2022). Violence among Nigerian Students: A Doom to Nigerian Educational System. South Asian Journal of Social Studies and Economics, 1–7. https://doi.org/10.9734/sajsse/2022/v14i430387

[14] Jude, E. P., and Chibuzor, E. P. (2023). Internal insecurity in Nigeria and the conundrum of out-of-school children. https://doi.org/10.4314/jda.v8i2.7

[15] Aghedo, I. (2015). Values and Violence Explaining the Criminalization of Higher Education Students in Nigeria. Journal of Black Studies, 46(2), 172–198. https://doi.org/10.1177/0021934714562959

[16] Likhovitskyi, J. O. (2024). Prevention of crime (criminal offenses) in the field of security activities. Naukovij Vìsnik Užgorods'kogo Nacìonal'nogo Unìversitetu, 3(84), 322–328. https://doi.org/10.24144/2307-3322.2024.84.3.49

[17] Jore, S. H. (2019). The Conceptual and Scientific Demarcation of Security in Contrast to Safety. 4(1), 157–174. https://doi.org/10.1007/S41125-017-0021-9

[18] Sowmyya, T. (2011). Crime: A Conceptual Understanding. Indian Journal of Applied Research, 4(3), 196–198. https://doi.org/10.15373/2249555X/MAR2014/58

[19] Wortley, R., and Mazerolle, L. (2016). Environmental criminology and crime analysis: situating the theory, analytic approach and application (Vol. 6, pp. 1–18). Routledge. https://doi.org/10.4324/9780203118214-8

[20] Andresen, M. A. (2014). Environmental Criminology: Evolution, Theory, and Practice. https://doi.org/10.4324/9780203728246

[21] Ceccato, V., and Ioannidis, I. (2024). Introduction to the special issue "environmental criminology in crime prevention: theories for practice." Security Journal. https://doi.org/10.1057/s41284-024-00440-6

[22] Bock, K., Shannon, S., Movahedi, Y., and Cukier, M. (2017). Application of Routine Activity Theory to Cyber Intrusion Location and Time. European Dependable Computing Conference, 139–146. https://doi.org/10.1109/EDCC.2017.24

[23] Application of the Theory of Routine Activities in Criminology to the General Crime Situation in Bosnia and Herzegovina. (2024). Pakistan Journal of Criminology. https://doi.org/10.62271/pjc.16.2.669.686

[24] Butorac, K., and Marinović, J. (2017). Geography of Crime and Geographic Information Systems. 2(4), 1–7. https://doi.org/10.19080/JFSCI.2017.02.555591

[25] Chang, K.-T. (2019). Geographic Information System. 1–10. https://doi.org/10.1002/9781118786352.WBIEG0152

[26] Secretary, E. (2023). Applications in Crime Prevention (pp. 83–93). https://doi.org/10.1007/978-981-19-6905-8_8

[27] Valasik, M. (2024). Crime Mapping and Spatial Analysis. Oxford Research Encyclopedia of Criminology and Criminal Justice. https://doi.org/10.1093/acrefore/9780190264079.013.821

[28] Mordwa, S. (2015). Techniki GIS – w poszukiwaniu hot spotów przestępczości. 37, 279–302. https://doi.org/10.7420/AK2015I

[29] Kannan, M., and Singh, M. (2020). Identifying Crime Hot Spots (pp. 95–118). CRC Press. https://doi.org/10.1201/9780429342554-4

[30] Achu, A. L., and Suja, R. S. (2016). GIS Analysis of Crime Incidence and Spatial Variation in Thiruvananthapuram City. International Journal of Remote Sensing Applications, 6, 1. https://doi.org/10.14355/IJRSA.2016.06.001

[31] Shafique, I., Zahra, S. A., Farid, T., and Sharif, M. (2017). Role of GIS in Crime Mapping and Analysis. 1(2), 39–47. https://doi.org/10.30537/SJCMS.V1I2.30

[32] Mohammed, A. F., and Baiee, W. R. (2020). Analysis of Criminal Spatial Events in GIS for predicting hotspots. 928(3), 032071. https://doi.org/10.1088/1757-899X/928/3/032071