Assessing Malaysia's Urban Security through Emerging Hot Spot Analysis (EHSA): A Spatiotemporal Investigation of Burglary Patterns within Police Jurisdictions of Selangor, Kuala Lumpur, and Putrajaya, Malaysia

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Abstract

This study investigates the spatiotemporal patterns of midnight burglary (12 am–6:59 am) across 84 Police Station Boundaries (PSBs) in Selangor, Kuala Lumpur, and Putrajaya using Emerging Hot Spot Analysis (EHSA). The research addresses critical issues in urban crime dynamics, particularly the impact of the COVID-19 pandemic on burglary trends. The objectives include identifying intensifying, diminishing, and other hotspot categories to enhance understanding of spatial crime distributions. A spatiotemporal design, utilizing advanced GIS tools, classifies crime hotspots into nuanced categories, enabling a comprehensive analysis of burglary trends from 2015–2020. Findings reveal significant disparities in burglary intensification in areas such as Kajang (8.60%), Selayang (4.73%), and Klang (4.56%), with diminishing trends observed in regions like Sri Muda. Oscillating and emerging patterns were noted in Kuang and Rawang. Conclusions emphasize the need for targeted, evidence-based law enforcement strategies to mitigate crime risks effectively. The study underscores implications for collaborative urban security policies, advocating for adaptive resource allocation and strategic interventions amidst evolving socio-economic disruptions. This work contributes to criminological literature by demonstrating the utility of EHSA in spatiotemporal crime analysis and informing public safety initiatives.

Keywords: Burglary Crime, Emerging Hot Spot Analysis (EHSA), Police Station Boundary, Spatial-Temporal Analysis

1. Introduction

Urban crime, particularly in the context of densely populated areas, has been the focal point of extensive research due to its higher incidence compared to rural settings. Urban environments are more susceptible to property crimes, violent crimes, and drug-related offences [1] and [2]. With the global urban population projected to exceed 70 percent by 2050, there is a pressing need for enhanced urban security measures [3] and [4].

Several factors contribute to the escalation of crime in these settings, including rapid urbanization, poverty, and socio-economic inequalities [5]. Urban crime imposes significant financial and social costs on communities, impacting public safety and necessitating substantial expenditures in law enforcement and criminal justice [6]. In Malaysia, burglary remains a critical concern, with a notable increase in criminal activities, particularly in economically disadvantaged neighbourhoods, heightening residents' fears and prompting a shift towards more secure living environments like gated communities [7][8] and [9]. The intricate spatio-temporal dynamics of burglary demand a nuanced understanding to formulate effective preventive strategies. The COVID-19 pandemic has introduced further complexities, reshaping the landscape of criminal activities, including commercial burglary [10][11] and [12]. Pandemic-induced changes in daily routines, business operations, and mobility patterns have significantly influenced burglary rates, underscoring the need for detailed spatial analysis and targeted interventions [13][14] and [15]. These observations underscore the pandemic's complex effects on crime patterns, highlighting the need for detailed analysis and intervention strategies [16] and [17].

Employing theoretical frameworks such as routine activity theory and situational crime prevention, this research employs advanced hotspot analysis techniques to identify geographic clusters of commercial burglary, offering fresh insights into the patterns and determinants of these incidents in the context of pandemic restrictions [18] and [19]. By exploring the interplay between pandemic-induced mobility restrictions and burglary patterns, this study aims to contribute to the enhancement of public safety and security during challenging times [11] and [20]. This study distinguishes itself through its methodological innovation and contextual relevance. Specifically, the integration of Emerging Hot Spot Analysis (EHSA) with Space-Time Pattern Mining (STPM) tools offers a robust approach to analyzing the spatiotemporal dynamics of burglary. Unlike traditional methods such as Getis-Ord Gi*, which often overlook temporal variations, EHSA classifies crime patterns into nuanced categories such as intensifying, diminishing, and oscillating enabling a more comprehensive understanding of crime trends.

Furthermore, the study uniquely examines how COVID-19-induced mobility restrictions and socio-economic shifts have influenced burglary patterns, contributing to the emerging body of research on pandemic-related crime dynamics. By focusing on urban regions in Selangor, Kuala Lumpur, and Putrajaya, the research provides both a detailed regional analysis and broader implications for urban environments globally. These findings underscore the importance of spatiotemporal crime analysis in shaping evidence-based, targeted intervention strategies, particularly in the face of socio-economic disruptions. Globally, burglary trends have varied, with general declines observed alongside localised increases in certain regions. The United Nations Office on Drugs and Crime (UNODC) reports a decrease in global burglary rates from 1996 to 2006, with recent data suggesting ongoing fluctuations [21] [22] and [23]. In Malaysia, the enforcement of the Movement Control Order (MCO) since March 2020 has played a crucial role in the observed reductions in property crimes, as reported by the Royal Malaysia Police [24] and [25]. This research delves into the relationship between societal restrictions and crime dynamics, illuminating the complex factors influencing burglary rates amid the pandemic (Figure 1).

This study seeks to address a significant gap in the existing literature by critically examining the impact of COVID-19-related restrictions on the spatial distribution of commercial burglary across Selangor, Kuala Lumpur, and Putrajaya. While prior research has extensively explored crime trends, there remains a paucity of studies investigating the specific influence of pandemic-induced closures on the geographical patterns of burglary in urban Malaysian settings. The COVID-19 pandemic introduced unprecedented disruptions to routine activities, economic stability, and mobility patterns, necessitating a revaluation of existing crime analysis methodologies.

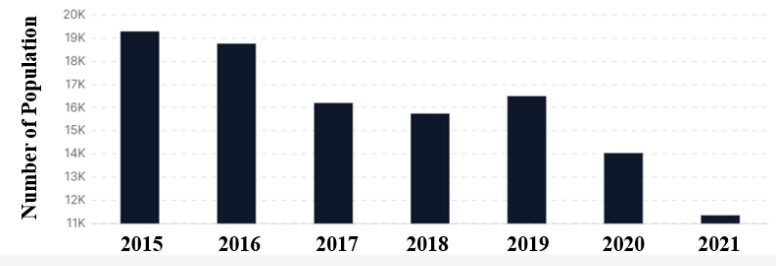

Figure 1: Graph of housebreaking crime in Malaysia 2015-2021 [24][26] and [27]

This study fills this void by analyzing spatial crime shifts before, during, and after pandemic-related restrictions. A key methodological advancement in this study is the application of Emerging Hot Spot Analysis (EHSA), which provides a robust alternative to conventional spatial-temporal crime mapping techniques. Traditional methods, such as the Getis-Ord Gi* statistic, have been widely utilized for crime hotspot detection but are inherently limited in their capacity to capture dynamic temporal fluctuations in crime trends, as highlighted by [28] [29][30] and [31]. These studies emphasize that conventional approaches often rely on static spatial representations that fail to account for evolving crime patterns over time. EHSA, by contrast, enables a more granular examination of the emergence, persistence, and dissipation of crime hotspots, making it particularly valuable in contexts where crime dynamics are subject to abrupt external shocks, such as those induced by the COVID-19 pandemic. The broad geographical scope of this study, spanning Selangor, Kuala Lumpur, and Putrajaya, enhances its empirical rigor by enabling a comprehensive assessment of the spatial distribution of burglary incidents across diverse urban environments. This expansive coverage facilitates a deeper understanding of crime dynamics by capturing variations across metropolitan, suburban, and peri-urban areas. Moreover, the study examines the influence of exogenous factors, particularly the pandemic, on crime patterns, including observable fluctuations in burglary rates in proximity to police stations. Recent studies [32][33] and [34] suggest that law enforcement presence has a measurable impact on crime deterrence, yet few have investigated how these effects evolved during the pandemic. By addressing this underexplored dimension, this research contributes to a more nuanced discourse on crime prevention and policing strategies in crisis conditions.

The findings of this study underscore the indispensable role of EHSA in augmenting the analytical depth of spatial crime studies. Unlike static spatial methods, EHSA provides a dynamic framework that identifies emergent, intensifying, and declining crime hotspots over time. This methodological enhancement enables a more precise characterization of burglary trends, facilitating targeted intervention strategies that align with the temporal fluctuations of crime patterns. By demonstrating the efficacy of EHSA, this study advocates for a paradigm shift in spatial crime analysis, urging researchers and policymakers to adopt more temporally responsive analytical frameworks. The ability to detect and predict shifts in crime hotspots is crucial for proactive law enforcement strategies, ultimately contributing to improved public safety and community resilience [35]. Another critical gap this study addresses pertains to the relationship between law enforcement presence and crime distribution, particularly in the context of police station locations. Criminological theories suggest that crime patterns are influenced by the spatial distribution of law enforcement resources; however, empirical evidence on how these dynamics were altered by pandemic-related restrictions remains limited. This study offers an empirical assessment of shifting burglary patterns near police stations, shedding light on the potential deterrent effects of law enforcement presence and how these may have been disrupted or reinforced during the pandemic.

Furthermore, much of the existing research on crime trends during the COVID-19 pandemic has been conducted in Western contexts, with relatively little attention given to urban crime patterns in Southeast Asia. Malaysia's urban centers, characterized by unique socio-economic and demographic factors, present a distinctive case that warrants dedicated study. By contextualizing pandemic-era crime trends within the Malaysian setting, this research contributes valuable regional insights that can enrich the global discourse on crime prevention and urban safety strategies. Despite the methodological advancements presented in this study, certain limitations must be acknowledged. While EHSA provides a sophisticated spatial-temporal analysis of burglary patterns, the exclusion of socio-economic variables represents a potential shortcoming. Crime trends are often influenced by complex socio-economic factors such as income inequality, employment instability, and population density. Future research should integrate these variables to further contextualize crime dynamics and enhance the explanatory power of spatial analyses. Understanding the socio-economic drivers of crime would allow for more holistic and effective crime prevention strategies, ensuring that policy interventions address not only spatial patterns but also the underlying socio-economic determinants of criminal behavior.

2. Materials and Methods

2.1 Study Area

Our research focuses on the contiguous urban regions of Selangor, Kuala Lumpur Federal Territory (KLFT), and Putrajaya Federal Territory (WFT), forming a dynamic socio-economic hub in Malaysia (Figure 2).

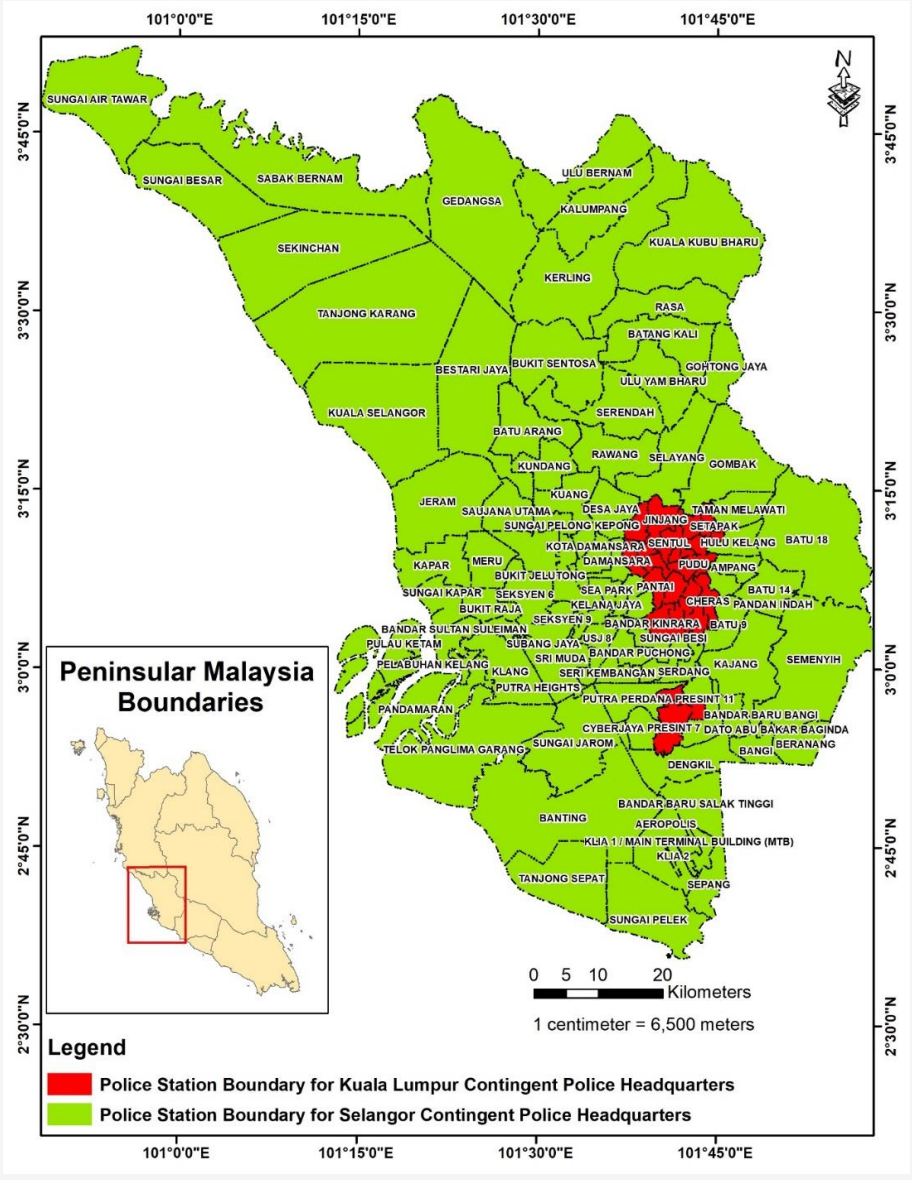

Figure 1: Police stations boundary for Selangor and Kuala Lumpur contingent police headquarters [36]

Selangor, a cornerstone of urban development, envelops Kuala Lumpur—the economic pulse of the nation, driving growth in the industrial and service sectors. It covers 7,950.91 square kilometers and hosts a population of 6,994,423, leading to a high population density of 880 persons per square kilometer [37] and [38]. The demographic profile reveals a male predominance, with a gender ratio of 113 males for every 100 females. Kuala Lumpur, despite its smaller area of 243 square kilometers, is densely populated with 1,982,112 residents, which equates to 8,157 people per square kilometer [39] and [40]. The city showcases Malaysia's urban sophistication and diversity, with gender dynamics slightly favouring males, similar to Selangor. Putrajaya, established in 1999 as the newest Federal Territory, spans 49.3 square kilometers and is noted for its administrative significance, housing 109,202 individuals and achieving a population density of 2,215 people per square kilometer [39] and [41]. Despite its modest size, it is central to national governance. Together, these regions offer a rich context for investigating urban development, socio-economic trends, and governance, providing a comprehensive backdrop for our study of burglary patterns. The demographic and socio-economic landscapes of these areas inform our analysis of the spatial distribution of burglary incidents, enabling the development of informed strategies for urban management and crime prevention [38].

2.2 Spatial and Non-Spatial Data

This study advances quantitative criminological analysis by utilizing an extensive secondary dataset collected from the Intelligence/Operations/Records Division of the Royal Malaysia Police Headquarters, spanning the years 2015 to 2020 [42]. This dataset is pivotal, providing a detailed view of the interplay between property and violent crimes within the urban contexts of Selangor, and the Kuala Lumpur and Putrajaya Federal Territories (KLFT and PFT) [43]. It includes critical incident details such as geographical locations, timestamps, and categories of crimes, enabling a comprehensive analysis of crime patterns across these regions [44] and [45]. Our methodological approach leverages the demographic and strategic importance of these areas by focusing on the boundaries of 111 police stations as defined within the Selangor and Kuala Lumpur Contingent Police Headquarters. The use of ArcMap enhances our capability to visualize the distribution of crime both spatially and temporally [46][47][48][49] and [50]. Additionally, advanced ArcGIS software is employed to aggregate and map the data at this granular level, facilitating not only a precise examination of crime distribution patterns but also a deeper understanding of the relationship between crime dynamics and police jurisdictional boundaries [34][42][43][44] and [45]. This dual approach of analyzing both spatial and non-spatial data encapsulates a holistic strategy, enabling the dissection of intricate crime patterns within these critical urban settings, thereby providing a robust foundation for subsequent analytical and preventive measures.

2.3 Emerging Hot Spot Analysis (EHSA)

In this study, Emerging Hot Spot Analysis (EHSA), in conjunction with Space Time Pattern Mining (STPM), is employed as a cutting-edge methodological approach within ArcGIS Pro 3.1 to uncover evolving trends in spatial point density and attribute values over time. EHSA classifies spatial trends into eight distinct categories—from emerging to historical hot spots providing a comprehensive temporal perspective on crime patterns [51]. By generating space-time cubes through STPM tools, EHSA utilizes the Spatial Relationship Concept to perform the Getis-Ord Gi* statistic, identifying significant hot spots with a Hot Spot Analysis that includes a False Discovery Rate (FDR) correction. This analytical process enriches each cube with essential statistical measures such as z-scores, p-values, and classifications, enabling a detailed analysis of spatial anomalies and their temporal developments [52]. The application of the Mann-Kendall trend test within this framework allows for an assessment of the temporal dynamics of identified hot and cold spots, enhancing our understanding of the evolution of crime patterns in Selangor, Kuala Lumpur, and Putrajaya [53]. With EHSA's robust classification system, which leverages z-score and p-value metrics for each location and hotspot statistics for each cube, the methodology provides valuable insights into the spatial-temporal dynamics of crime. This approach not only sheds light on the current state of crime hotspots but also informs future policy and intervention strategies, aiming to foster safer urban environments.

3. Result and Discussion

3.1 Midnight Burglary (12am-6.59am)

The analysis focusing on midnight burglary incidents within the Selangor, Kuala Lumpur, and Putrajaya regions, as depicted in Figure 3 and Table 1, reveals a complex interplay between the timing of burglary occurrences and the spatial dimensions of Police Station Boundaries. Utilizing Emerging Hot Spot Analysis (EHSA), our study identifies significant variances in burglary intensification across 84 Police Station Boundaries, showcasing a range of hot spot categories including new, consecutive, intensifying, persistent, diminishing, sporadic, oscillating, and historical. We identified 84 Police Station Boundaries exhibiting notable hot spot characteristics. Regarding the intensifying of Burglary Crime within Police Station Boundaries, the analysis reveals significant variations. The intricate relationship between the temporal dynamics of Burglary Crime occurrences at midnight and the spatial extent of Police Station Boundaries, as elucidated in this study, unveils a complex interplay of factors influencing crime patterns. The identified hot spots, categorized into various types based on the Emerging Hot Spot Analysis (EHSA), reflect diverse patterns of Burglary Crime distribution, ranging from persistent clusters to sporadic occurrences. The analysis further reveals significant variations in the intensifying and persistence of Burglary Crime across different Police Station Boundaries, underscoring the need for tailored law enforcement strategies and resource allocation to address varying crime dynamics. The findings of this study hold significant implications for urban security and law enforcement policies, particularly in the context of the COVID-19 pandemic. With the pandemic altering social and economic dynamics, there is a heightened need for proactive crime prevention measures and targeted intervention strategies.

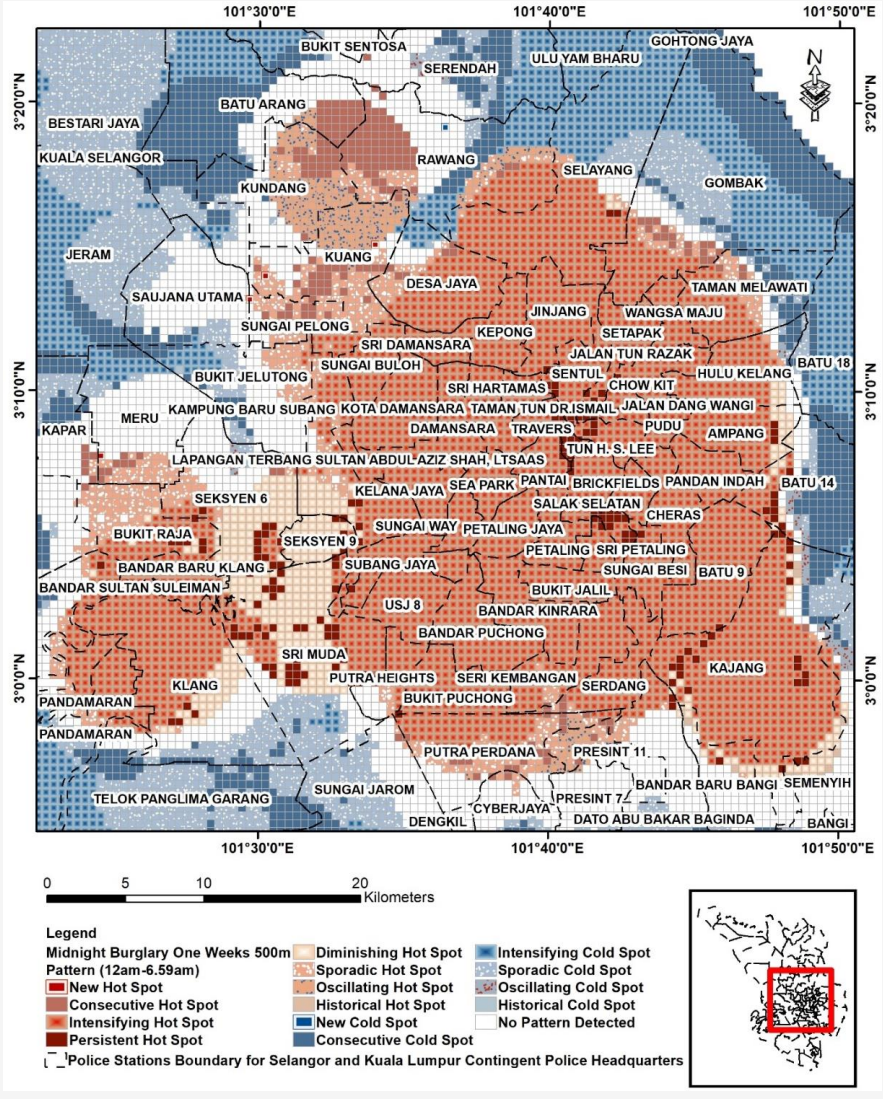

Figure 3: Midnight (12.00 a.m. - 6.59 a.m.) Burglary EHSA by 1 weeks and 500 m

The identification of hot spots and understanding their spatiotemporal dynamics can aid law enforcement agencies in optimizing resource allocation, deploying patrols, and implementing targeted interventions to mitigate Burglary Crime risks. Moreover, the findings underscore the importance of collaborative efforts between law enforcement agencies, urban planners, and policymakers to develop comprehensive crime prevention strategies that address both short-term fluctuations and long-term trends in Burglary Crime. The most pronounced areas of burglary intensification are found in Kajang, Selayang, and Klang, with the least intensification noted in Seksyen 9, Presint 11, Sungai Jarom, and Sungai Kapar, cumulatively covering an area of 983.22 km^2. The distribution of sporadic burglary incidents is also analyzed, highlighting areas with both high and low percentages of occurrences, totaling 137.55 km^2. Similarly, consecutive burglary occurrences show distinct spatial patterns, with Rawang, Kuang, and Batu Arang experiencing the highest percentages, and a cumulative area of 61.92 km^2 noted for these incidents. The study further identifies areas experiencing a diminishing trend in burglary crime, with notable regions including Sri Muda, Seksyen 6, and Klang, summing to a total area of 106.9 km^2. Persistent hot spots are recognized, illustrating the enduring nature of burglary in specific locales, totalling 46.26 km^2. Oscillating patterns of burglary distribution are observed, signifying fluctuating crime rates in particular areas, with a total area of 46.75 km^2 identified.

Table 1: Midnight (12.00 a.m. - 6.59 a.m.) Burglary EHSA by 1 weeks and 500 m

EHSA burglary crime	Three highest-ranked	
	City	Area: km^2 [Percentage]
Intensifying	Kajang	84.54 [8.60]
	Selayang	46.49 [4.73]
	Klang	44.87 [4.56]
Sporadic	Kuang	14.97 [10.88]
	Putra Perdana	14.52 [10.56]
	Bukit Raja	13.3 [9.69]
Consecutive	Rawang	17.65 [28.50]
	Kuang	7.30 [11.79]
	Batu Arang	7.13 [11.51]
Diminishing	Sri Muda	34.76 [32.52]
	Seksyen 6	20.23 [18.92]
	Klang	10.20 [9.54]
Persistent	Sri Muda	10.73 [23.19]
	Kampung Baru Subang	5.66 [12.24]
	Seksyen 6	3.60 [7.78]
Oscillating	Kundang	17.73 [37.93]
	Kuang	16.00 [34.22]
	Rawang	4.65 [9.95]
New Hot Spot	Sungai Pelong	0.65 [43.33]
	Kuang	0.50 [33.33]
	Meru	0.20 [13.33]
Historical	Semenyih	1.35 [45.00]
	Kajang	0.90 [30.00]
	Bandar Baru Bangi	0.50 [16.67]

Table 2: EHSA for Burglary Crimes in the Morning (7.00 a.m. -11.59 a.m.) by 1 weeks and 500 m

EHSA burglary crime	Three highest-ranked	
	City	Area: km^2 [Percentage]
Intensifying	Kajang	98.97 [8.78]
	Klang	54.35 [4.82]
	Selayang	46.81 [4.15]
Sporadic	Sri Muda	24.18 [15.77]
	Kuang	19.75 [12.88]
	Kundang	12.27 [8.00]
Consecutive	Rawang	20.54 [20.97]
	Kuang	11.58 [11.82]
	Sungai Besar	10.44 [10.66]
Diminishing	Bukit Raja	6.74 [27.79]
	Bukit Jelutong	4.43 [18.27]
	Kampung Baru Subang	2.57 [10.60]
Persistent	Bukit Raja	3.78 [18.89]
	Semenyih	3.74 [18.69]
	Bukit Jelutong	2.35 [11.74]
Oscillating	Semenyih	18.55 [27.02]
	Kuang	14.00 [20.39]
	Kundang	10.22 [14.88]
Historical	Semenyih	0.41 [27.02]
	Kuang	0.31 [20.39]
	Kundang	0.22 [14.88]

New hot spots of burglary crime are emerging, indicating areas of recent crime escalation, with a minimal cumulative area of 1.5 km^2. Historical hot spots persist, marking regions with long-standing burglary concerns, totalling an area of 3.00 km^2.

This comprehensive investigation illuminates the intricate spatiotemporal patterns of burglary crime within the Selangor, Kuala Lumpur, and Putrajaya areas, leveraging the innovative application of Emerging Hot Spot Analysis (EHSA).

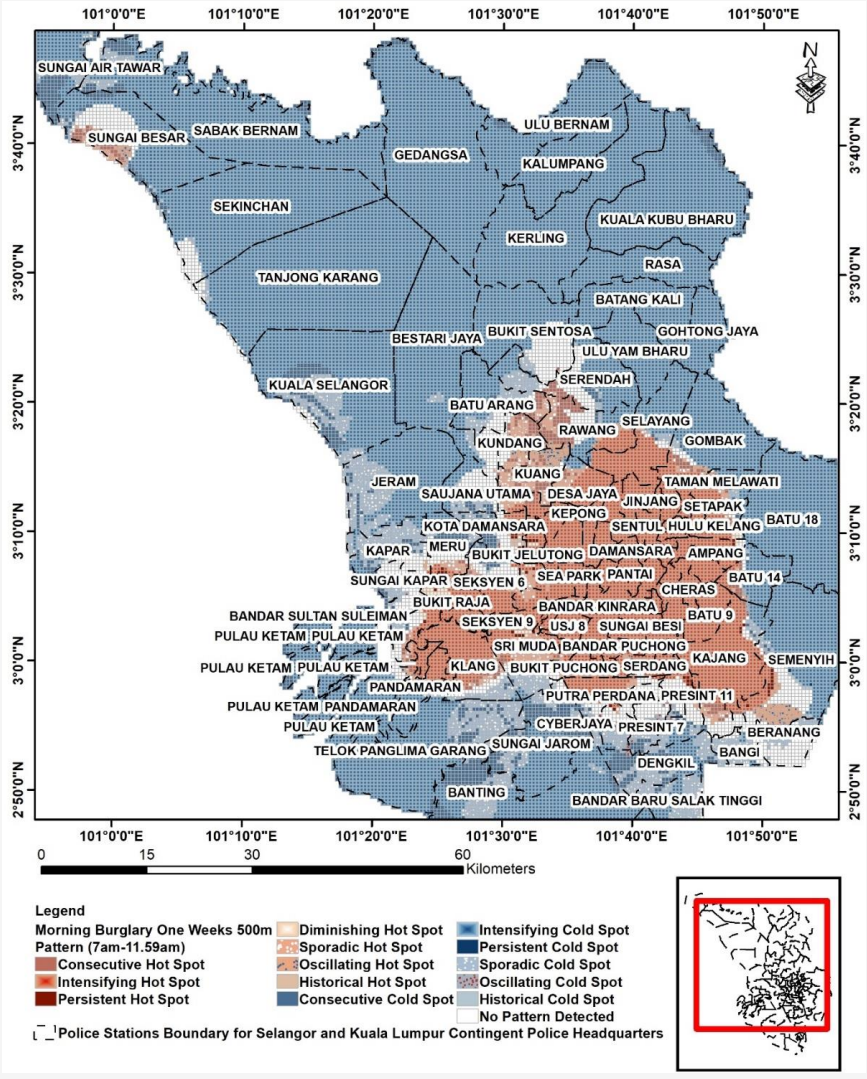

Figure 4: EHSA for Burglary Crimes in the Morning (7.00 a.m. -11.59 a.m.) by 1 weeks and 500 m

The study's nuanced examination reveals a spectrum of burglary distribution trends, from enduring hot spots to transient anomalies. These insights are critical for developing customized approaches in law enforcement, optimizing resource deployment, and formulating urban security policies that address the unique challenges presented by varying crime patterns. The evolving socio-economic conditions, further complicated by the COVID-19 pandemic, accentuate the necessity for dynamic, evidence-based strategies in crime prevention and public safety management. The collaboration across sectors including law enforcement agencies, urban planners, and policy makers—emerges as a pivotal strategy for comprehensively tackling burglary crime risks [54]. There is a pressing need for continued research to delve into the causative factors underlying these burglary crime patterns. Such investigations are essential for crafting well-informed, effective strategies aimed at bolstering urban security and preempting crime. This study not only contributes valuable knowledge to the field of urban criminology but also underscores the importance of adaptive, data-driven approaches in crime prevention and urban planning [55].

3.2 Morning Burglary (7a.m.- 11.59 a.m.)

This segment delves into the morning period analysis of burglary incidents within the Selangor, Kuala Lumpur, and Putrajaya regions, as illustrated in Figure 4 and Table 2. Through Emerging Hot Spot Analysis (EHSA), this study identifies a comprehensive array of burglary patterns across 84 police station boundaries. The analysis underscores significant variances in the intensity of burglary occurrences, revealing a complex landscape of crime dynamics influenced by the timing and spatial configurations of police jurisdictions.

Furthermore, this analysis reveals that the areas with the highest intensifying of burglary crime within police station boundaries are Kajang (98.97 km^2-8.78%), Klang (54.35 km^2-4.82%), and Selayang (46.81 km^2-4.15%). This intricate relationship between the temporal dynamics of burglary crime occurrences at midnight and the spatial boundaries of police stations unveils a complex interplay of factors influencing crime patterns. The identified hot spots, categorized into various types based on the Emerging Hot Spot Analysis (EHSA), reflect diverse patterns of burglary crime distribution, ranging from persistent clusters to sporadic occurrences. Additionally, significant variations in the intensifying and persistence of burglary crime across different police station boundaries underscore the need for tailored law enforcement strategies and resource allocation to address varying crime dynamics.

The key findings from this analysis are as follows as Intensification of Burglary Crime: Notable areas such as Kajang, Klang, and Selayang emerged as regions with the highest levels of burglary intensification, whereas Sungai Kapar, Presint 11, and Sungai Jarom reported the lowest, summing up to an aggregate area of 1127.48 km^2 experiencing increased burglary activity. Sporadic Burglary Crime Patterns show the analysis points to Sri Muda, Kuang, and Kundang as areas with the most pronounced sporadic burglary patterns, contrasting sharply with the minimal occurrences in Sungai Jarom, Presint 11, and Lapangan Terbang Sultan Abdul Aziz Shah (LTSAAS), accounting for a total of 153.37 km^2. Meanwhile Consecutive Burglary Incidents: Highlighting a significant concern, Rawang, Kuang, and Sungai Besar were identified as hotspots for consecutive burglary events, with the total area affected being 97.96 km^2. Diminishing Burglary Trends Areas such as Bukit Raja, Bukit Jelutong, and Kampung Baru Subang show a diminishing trend in burglary crime, totaling 24.25 km^2. Persistence of Burglary Crime hotspots were predominantly observed in Bukit Raja, Semenyih, and Bukit Jelutong, indicating enduring crime challenges in these locales, cumulatively affecting an area of 20.01 km^2. Oscillating Burglary Crime Distribution study unveils oscillating patterns of burglary distribution in Semenyih, Kuang, and Kundang, with a total affected area of 68.66 km^2. Historical Burglary Crime Hotspots analysis reveals consistent burglary concerns in areas like Semenyih, Kuang, and Kundang, with a minimal total area of 1.5 km^2 identified as historical hotspots.

The intricate relationship between burglary crime timing and police station spatial boundaries highlights the complexity of urban crime patterns. The diversity of burglary crime distribution, from persistent hotspots to diminishing areas, necessitates nuanced, targeted approaches in law enforcement strategy, resource distribution, and urban planning. The evolving challenges posed by the COVID-19 pandemic further emphasize the need for adaptive crime prevention measures and strategic interventions [56]. Understanding the spatiotemporal dynamics of burglary hotspots is crucial for optimizing law enforcement resources, enhancing patrol deployments, and implementing focused crime mitigation strategies. Collaboration across law enforcement, urban planning, and policy-making spheres is essential for devising comprehensive crime prevention frameworks. Addressing both immediate crime trends and long-term patterns is vital for ensuring urban safety and security [57].

3.3 Evening Burglary (12 p.m. - 6.59 p.m.)

This section examines the evening period of burglary incidents across the Selangor, Kuala Lumpur, and Putrajaya regions, employing Emerging Hot Spot Analysis (EHSA) to map the spatial and temporal dynamics within police station boundaries. The study uncovers a multifaceted landscape of burglary crime intensification and distribution patterns, contributing to a deeper understanding of urban crime phenomena. The findings presented in Figure 5 and Table 3 illuminate the intricate relationship between the temporal dynamics of burglary incidents occurring at midnight and the spatial extents of police station jurisdictions, measured in square kilometers (km^2), across the Selangor, Kuala Lumpur, and Putrajaya regions. Employing the innovative framework of Emerging Hot Spot Analysis (EHSA), incorporating diverse classifications such as new, consecutive, intensifying, persistent, diminishing, sporadic, oscillating, and historical hot spots.

This nuanced interplay between the temporal dynamics of burglary occurrences at midnight and the spatial demarcations of police stations unveils a complex amalgamation of factors influencing crime patterns. The identified hot spots, classified into various types based on EHSA, depict diverse burglary crime distribution patterns, ranging from persistent clusters to sporadic occurrences. Furthermore, significant variations in burglary crime intensity and persistence across different police station boundaries emphasize the necessity for customized law enforcement strategies and resource allocation to address varying crime dynamics. The implications of these findings for urban security and law enforcement policies, particularly in the context of the COVID-19 pandemic, are profound.

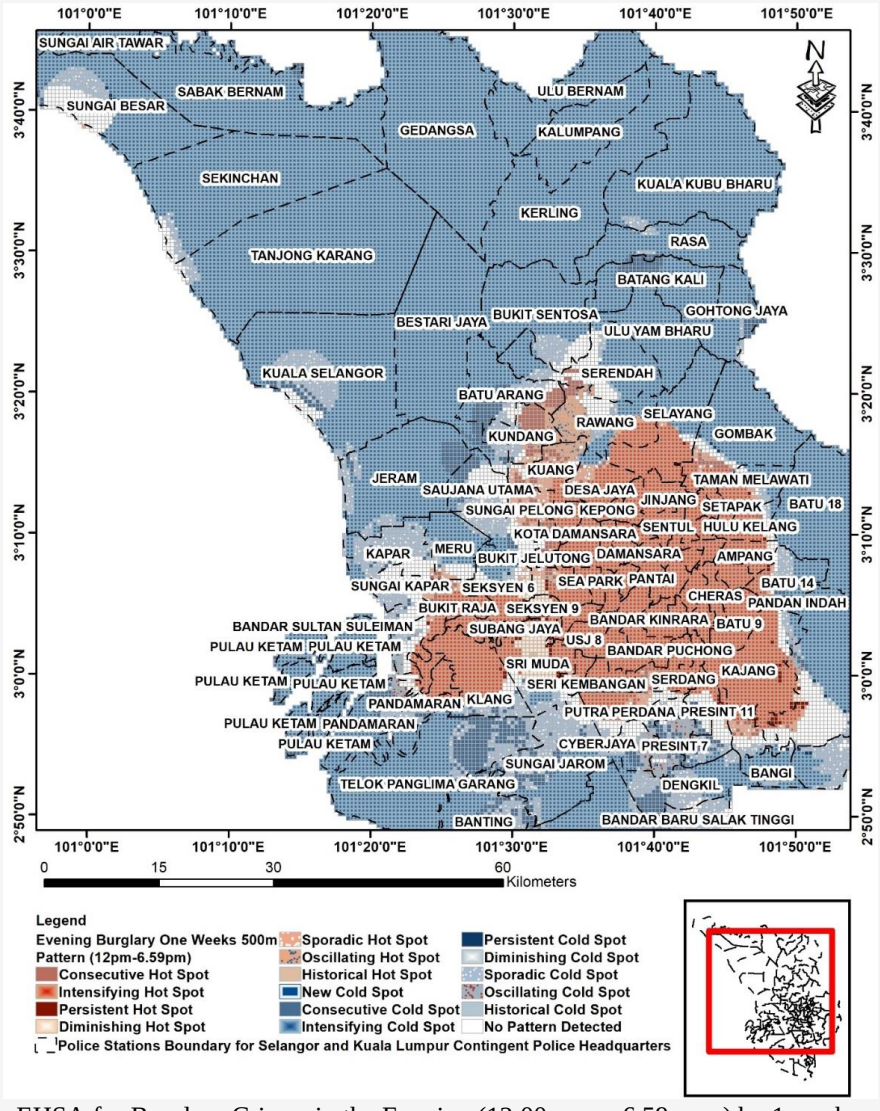

Figure 5: EHSA for Burglary Crimes in the Evening (12.00 a.m. -6.59 p.m.) by 1 weeks and 500 m

With the pandemic reshaping social and economic landscapes, proactive crime prevention measures and targeted intervention strategies are imperative. The identification and understanding of hot spots' spatiotemporal dynamics can aid law enforcement agencies in optimizing resource allocation, deploying patrols, and implementing targeted interventions to mitigate burglary crime risks. Moreover, these findings underscore the importance of collaborative efforts among law enforcement agencies, urban planners, and policymakers in developing comprehensive crime prevention strategies that address short-term fluctuations and long-term trends in burglary crime.

In conclusion, this study offers invaluable insights into the spatiotemporal dynamics of burglary crime and its association with police station boundary sizes within the Selangor, Kuala Lumpur, and Putrajaya regions. By leveraging EHSA, the study identifies distinct burglary crime distribution patterns, emphasizing the need for tailored law enforcement strategies, resource allocation, urban security policies, and collaborative efforts among stakeholders to effectively address burglary crime risks, particularly amidst the evolving social and economic landscape induced by the COVID-19 pandemic. The comprehensive analysis provided by this study underscores the complexity of burglary crime dynamics and the need for nuanced, targeted law enforcement responses. The variations in burglary crime patterns necessitate adaptive strategies, precise resource allocation, and the development of effective urban security policies to mitigate risks and protect communities [58].

Table 3: EHSA for Burglary Crimes in the Evening (12.00 p.m. - 6.59 p.m.) by 1 weeks and 500 m

EHSA burglary crime	Three highest-ranked	
	City	Area: km^2 [Percentage]
Intensifying	Kajang	96.94 [8.98]
	Klang	57.57 [5.33]
	Selayang	46.77 [4.33]
Sporadic	Kuang	15.99 [17.66]
	Sungai Pelong	8.47 [9.35]
	Bukit Raja	7.32 [8.08]
Consecutive	Kundang	15.34 [19.36]
	Kuang	10.39 [13.11]
	Kampung Baru Subang	8.59 [10.84]
Diminishing	Sri Muda	28.61 [60.56]
	Seksyen 6	5.49 [11.62]
	Bukit Jelutong	4.36 [9.23]
Persistent	Seksyen 9	5.00 [21.07]
	Sri Muda	4.85 [20.44]
	Kajang	3.67 [15.47]
Oscillating	Rawang	29.98 [50.60]
	Kundang	10.59 [17.87]
	Kuang	9.49 [16.02]
Historical	Sri Muda	1.50 [51.90]
	Klang	0.75 [25.95]
	Semenyih	0.25 [8.65]

The findings stress the importance of collaborative efforts among various stakeholders, including law enforcement agencies, urban planners, and policymakers, to devise and implement comprehensive crime prevention strategies. These strategies must be flexible enough to address both immediate concerns and long-term trends in burglary crime, especially in light of the ongoing impacts of the COVID-19 pandemic on social and economic conditions [59].

3.4 Night Burglary (7 p.m.- 11.59 p.m.)

The analysis of Police Station Boundary Consecutive Percentage Area (km^2) indicated differing degrees of concentration, with Rawang (15.89 km^2, 14.98%), Bukit Raja (13.23 km^2, 12.47%), and Putra Perdana (13.14 km^2, 12.39%) exhibiting the highest concentrations, and Serdang, Klang, and Sungai Kapar registering the lowest concentrations (all < 0.11 km^2, < 0.10%). The cumulative area encompassing consecutive hot spots amounted to 106.08 km^2. Similarly, the examination of Police Station Boundary Diminishing Percentage Area (km^2) showcased variances in distribution, with Semenyih (7.93 km^2, 20.73%), Kajang (6.44 km^2, 16.84%), and Seksyen 6 (5.99 km^2, 15.66%) representing the highest concentrations, juxtaposed with Bukit Raja, Ampang, and Bandar Baru Klang (all < 1.00 km^2, < 1.00%) registering the lowest concentrations. The cumulative area delineating diminishing hot spots amounted to 38.25 km^2. Moreover, the analysis of Police Station Boundary Persistent Percentage Area (km^2) illustrated disparities in persistence, with Semenyih (7.93 km^2, 20.73%), Kajang (6.44 km^2, 16.84%), and Seksyen 6 (5.99 km^2, 15.66%) exhibiting the highest concentrations, while Bukit Raja, Ampang, and Bandar Baru Klang (all < 1.00 km^2, < 1.00%) manifested the lowest concentrations. The total area delineating persistent hot spots amounted to 39.91 km^2.

Additionally, the examination of Police Station Boundary Oscillating Percentage Area (km^2) revealed variations in oscillation, with Kundang (19.26 km^2, 36.85%), Rawang (14.52 km^2, 27.78%), and Kuang (12.08 km^2, 23.12%) demonstrating the highest proportions, while Desa Jaya, Putra Perdana, and Taman Melawati (all < 1.00 km^2, < 1.00%) exhibited the lowest proportions. The total area delineating oscillating hot spots amounted to 52.26 km^2. Furthermore, the analysis of Police Station Boundary Historical Percentage Area (km^2) displayed fluctuations in historical trends, with Klang (1.81 km^2, 36.13%), Kampung Baru Subang (1.04 km^2, 20.76%), and Bandar Baru Bangi (0.74 km^2, 14.77%) representing the highest concentrations, while Sri Muda, Dato Abu Bakar Baginda, and Bukit Jelutong (all < 1.00 km^2, < 10.00%) portrayed the lowest concentrations. The cumulative area delineating historical hot spots amounted to 5.01 km^2.

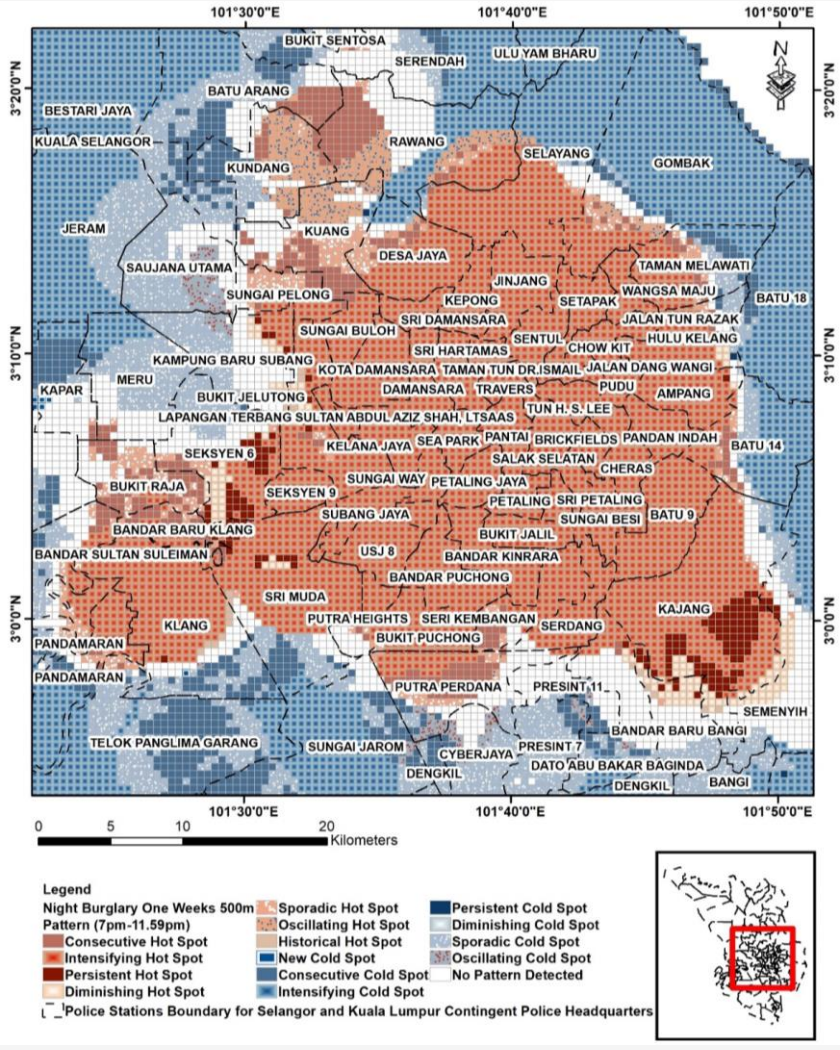

Figure 6: EHSA for Burglary at Night (7.00 p.m.-11.59 p.m.) by 1 weeks and 500 m

This comprehensive examination provides valuable insights into the spatial distribution of burglary incidents across various police station boundaries from 2015 to 2020 (Figure 6 and Table 4). These findings underscore the need for tailored law enforcement strategies and resource allocation to effectively address varying crime dynamics, particularly amidst the challenges posed by the COVID-19 pandemic. A detailed examination of the Police Station Boundary Intensifying Percentage Area has uncovered significant disparities, with Kajang, Sri Muda, and Klang showing the highest levels of crime intensification, whereas notably lower concentrations were observed in Bandar Baru Bangi, Presint 11, and Sungai Jarom. This analysis identifies a cumulative area of 1020.12 km^2 experiencing an intensification of burglary incidents, indicating specific regions where law enforcement efforts might need to be concentrated. Furthermore, the study identifies diverse patterns in sporadic, consecutive, diminishing, persistent, and oscillating burglary distributions across the studied regions. For instance, high sporadic percentages in Bukit Raja, Kuang, and Sungai Pelong contrast with minimal occurrences in areas like Bandar Puchong and Bukit Sentosa. Similarly, Rawang, Bukit Raja, and Putra Perdana emerged as areas with significant consecutive burglary activity, highlighting areas where continuous surveillance and preventive measures could be beneficial. Diminishing trends in Semenyih, Kajang, and Seksyen 6, alongside persistent hot spots in similar regions, suggest areas where long-term strategies have potentially begun to impact burglary rates, yet continued focus is required to sustain these reductions. Oscillating patterns, notably in Kundang, Rawang, and Kuang, reveal the fluctuating nature of burglary incidents, underscoring the complexity of predicting and managing such crimes effectively.

Table 4: EHSA for Burglary at Night (7.00 p.m.-11.59 p.m.) by 1 weeks and 500 m

EHSA burglary crime	Three highest-ranked	
	City	Area: km^2 [Percentage]
Intensifying	Kajang	72.50 [7.11]
	Sri Muda	57.13 [5.60]
	Klang	54.26 [5.32]
Sporadic	Bukit Raja	9.55 [13.06]
	Kuang	9.02 [12.33]
	Sungai Pelong	8.24 [11.27]
Consecutive	Rawang	15.89 [14.98]
	Bukit Raja	13.23 [12.47]
	Putra Perdana	13.14 [12.39]
Diminishing	Semenyih	7.93 [20.73]
	Kajang	6.44 [16.84]
	Seksyen 6	5.99 [15.66]
Persistent	Kajang	20.92 [52.42]
	Seksyen 6	9.03 [22.63]
	Sri Muda	3.83 [9.60]
Oscillating	Kundang	19.26 [36.85]
	Rawang	14.52 [27.78]
	Kuang	12.08 [23.12]
Historical	Klang	1.81 [36.13]
	Kampung Baru Subang	1.04 [20.76]
	Bandar Baru Bangi	0.74 [14.77]

Moreover, the historical analysis brings to light regions like Klang and Kampung Baru Subang, which have consistently been affected by burglary over the years, emphasizing the necessity for targeted historical crime analysis and intervention strategies.

The analysis reveals compelling insights into the spatial distribution of burglary incidents, delineating distinct patterns across various police station boundaries. Notably, the examination of Police Station Boundary Intensifying, Sporadic, Consecutive, Diminishing, Persistent, Oscillating, and Historical hot spots highlights notable variations in burglary crime distribution patterns, underscoring the need for tailored law enforcement strategies and resource allocation to address diverse crime dynamics. Of particular significance are the areas exhibiting high percentages of intensifying and persistent hot spots, such as Kajang, Sri Muda, and Klang, which necessitate targeted interventions to curb burglary crime risks effectively. Conversely, areas with sporadic and diminishing hot spots, such as Bukit Raja and Ampang, require nuanced approaches to prevent potential escalation and mitigate existing crime trends.

The insights derived from this study bear significant implications, particularly within the altered social and economic contexts brought about by the COVID-19 pandemic. The pandemic's transformative impact necessitates proactive crime prevention and targeted intervention strategies to adapt to the changing dynamics of crime. This research underscores the critical role of collaborative efforts among law enforcement, urban planning bodies, and policymakers in crafting and implementing comprehensive crime prevention strategies. These strategies, informed by the nuanced understanding of the spatiotemporal dynamics of burglary crime revealed through Emerging Hot Spot Analysis (EHSA), should adeptly navigate both the immediate fluctuations and the overarching trends in burglary incidents [60]. Effective resource allocation and the initiation of proactive measures are essential for bolstering urban security and mitigating burglary crime risks. In essence, this investigation into the burglary crime landscape within the Selangor, Kuala Lumpur, and Putrajaya regions, facilitated by the application of EHSA, unveils distinct patterns of crime distribution. It highlights the necessity for law enforcement strategies that are not only tailored to the unique characteristics of these patterns but also responsive to the evolving challenges posed by the COVID-19 pandemic. The study advocates for a concerted approach in policy formulation and resource distribution, urging stakeholders to engage in collaborative efforts aimed at comprehensively addressing the nuances of burglary crime [61].

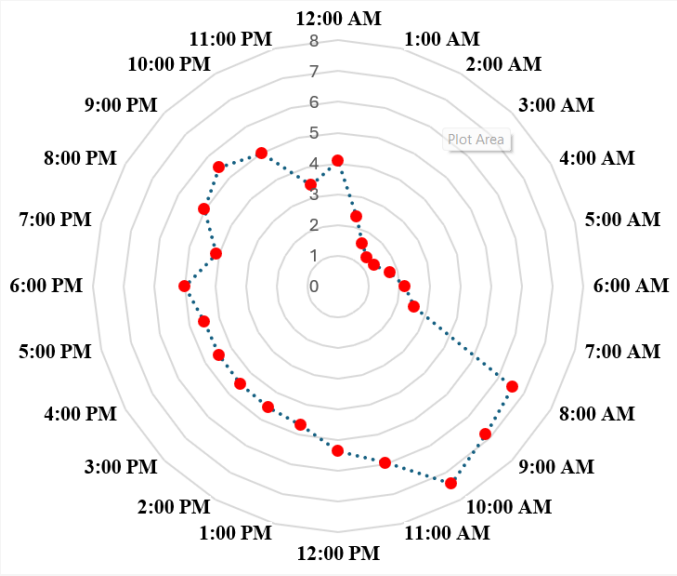

Figure 7: Radar Graph of the Percentage of Burglary Crime Incidents in a 24-Hour Period [62]

3.5 Result of Time

The spatiotemporal examination of burglary crime represents a pivotal endeavor in elucidating the intricate dynamics of criminal activities across various time intervals, shedding light on the temporal fluctuations in victimization patterns. This study delineates time (Aspatial data) into four discrete periods: midnight, morning, evening, and night, acknowledging the diverse daily routines and behaviors of individuals that may influence their susceptibility to crime. The unique routines of individuals during weekdays as opposed to weekends, along with variations across different days of the week, harbor the potential to predispose them to criminal victimization, thereby engendering discernible crime patterns over time [63][64] and [65]. In this study, we conducted a comprehensive spatiotemporal analysis of burglary crime incidents from 2015 to 2020, with a particular focus on the impact of COVID-19 on crime patterns. Our findings reveal distinct temporal patterns in criminal activity, emphasizing the critical role of time in understanding and preventing burglary crimes (Figure 7).

During the late-night hours, particularly at 1 am (2.82%), a conspicuous peak in criminal incidents is observed, accentuating the vulnerability of individuals during this temporal window. Conversely, the early morning hours, such as 3 am (2.04%), exhibit a diminished incidence of crime, likely attributable to decreased human activity and heightened vigilance. This finding underscores the need for enhanced vigilance and security measures during late-night hours, especially amidst the disruptions caused by the COVID-19 pandemic.

The morning hours, featuring 11 am (5.42%) as the peak, manifest a distinct pattern, indicative of the transitional phase from nocturnal to diurnal activities, while 7 am (1.83%) registers a downturn in criminal occurrences. Remarkably, the evening emerges as a pivotal temporal epoch characterized by a notable upsurge in violent crime, reaching its zenith at 3 pm (5.94%), underscoring the imperative of temporal awareness in the formulation of crime prevention strategies. Conversely, the advent of night, particularly at 9 pm (5.65%), witnesses a substantial proportion of criminal incidents, suggesting a perpetuation of criminal activities into the nocturnal hours, albeit at a slightly moderated rate compared to the evening peak. The nadir of crime incidence during the night is observed at 11 pm (3.77%), indicative of a gradual waning of criminal activities as the night unfolds. This nuanced spatiotemporal analysis unveils a distinct temporal pattern in violent crime, characterized by a pronounced concentration of incidents during the evening hours, notably at 3 pm (5.94%), followed by a gradual attenuation in criminal activities throughout the night. The spatiotemporal analysis of burglary crime conducted in this study is instrumental in uncovering the complex dynamics of criminal activities across different times of the day, revealing how temporal fluctuations impact victimization patterns. By segmenting the day into four distinct periods—midnight, morning, evening, and night, this research acknowledges the significant influence of daily routines and behaviors on individuals' vulnerability to crime.

Such temporal insights, coupled with the understanding that routines vary between weekdays and weekends and among different days, provide a nuanced perspective on how these variations may predispose individuals to criminal victimization, leading to identifiable crime patterns over time. Our comprehensive analysis spans from 2015 to 2020, with a keen focus on the ramifications of the COVID-19 pandemic on crime patterns. The findings illuminate distinct temporal crime patterns, highlighting the pivotal role of time in both understanding and preventing burglary crimes. Notably, a pronounced peak in criminal incidents at 1 am suggests a heightened vulnerability during these late-night hours. In contrast, the early morning hours, such as 3 am, see a reduction in crime incidents, likely due to decreased human activity and possibly increased vigilance among those still awake.

The study also reveals a significant surge in criminal activity during the evening, peaking notably at 3 pm, which underscores the need for crime prevention strategies that are acutely aware of temporal dynamics. Similarly, the night period experiences a substantial volume of criminal incidents, with a peak at 9 pm, indicating the continuation of criminal activities into the later hours, albeit at a slightly reduced rate compared to the evening peak. This gradual decline in crime incidents as the night progresses, reaching its lowest at 11 pm, suggests a tapering off of criminal activities. These temporal variations are crucial for law enforcement agencies and policymakers in crafting targeted interventions to mitigate victimization risks during identified peak crime periods. The findings emphasize the necessity for implementing crime prevention strategies that are sensitive to these specific temporal patterns, thereby enhancing public safety and building resilient communities.

Furthermore, the observations from this study offer critical insights for urban planners and public safety officials, enabling more effective resource allocation and the deployment of law enforcement measures during times of heightened crime rates. Enhanced lighting, surveillance, and environmental design can serve as potent deterrents against criminal behavior during vulnerable periods, particularly in the evening and nighttime [66]. In sum, this research underscores the significance of spatiotemporal analysis in elucidating the intricacies of burglary crime dynamics, especially against the backdrop of the COVID-19 pandemic. By dissecting time into specific periods and examining the temporal variations in crime incidence, the study equips law enforcement agencies and policymakers with invaluable insights for devising precise, time-sensitive interventions. Such strategies, tailored to combat peak crime periods, are vital for bolstering public safety and fostering community resilience in urban settings [35].

4. Conclusion

This study provides a comprehensive examination of the spatiotemporal dynamics of burglary incidents across Selangor, Kuala Lumpur, and Putrajaya using Emerging Hot Spot Analysis (EHSA). By integrating spatial and temporal dimensions, the research identifies distinct patterns of burglary crimes, categorized into intensifying, diminishing, sporadic, oscillating, and persistent hotspots. The findings highlight critical areas such as Kajang, Klang, and Selayang, which exhibit high levels of burglary intensification, alongside regions with diminishing trends, such as Sri Muda and Bukit Jelutong. These insights emphasize the complexity of burglary distribution and the need for tailored interventions. The temporal analysis further reveals significant variations in crime activity throughout the day, with peaks during late-night and evening hours. This underscores the necessity of time-sensitive law enforcement strategies and resource allocation to address heightened vulnerabilities during these periods. The study also highlights the enduring impact of the COVID-19 pandemic on burglary patterns, emphasizing the importance of adaptive crime prevention strategies in the face of evolving socio-economic disruptions.

This research has profound implications for urban security policies and collaborative crime prevention efforts. By utilizing advanced spatial-temporal tools like EHSA, law enforcement agencies, urban planners, and policymakers can develop evidence-based strategies to mitigate crime risks effectively. The results underline the importance of inter-agency collaboration to implement long-term solutions that address both current and emerging crime trends. In conclusion, this study contributes to the broader understanding of urban crime dynamics, offering actionable insights for enhancing public safety. It calls for continued research into the socio-economic factors influencing crime patterns and the application of innovative technologies, such as predictive analytics, to refine prevention strategies. By fostering a data-driven and collaborative approach, stakeholders can create resilient urban environments that prioritize safety and well-being.

5. Limitations of the Study

This study's temporal scope (limited to data up to the year 2020) restricts our analysis of the ongoing impacts of the COVID-19 pandemic and subsequent socio-economic changes on burglary patterns. An extension of this dataset to include more recent years

would be valuable, allowing for a longitudinal evaluation of trends and the effectiveness of interventions deployed during and after the pandemic. Such an expansion would enhance our understanding of the persistence of these patterns over a longer term [67]. Although the study effectively utilizes crime data and Geographic Information Systems (GIS), it lacks integration with broader socio-economic factors such as income distribution, unemployment rates, and demographic shifts. Future research could improve this by incorporating these socio-economic variables, which are likely to influence burglary patterns. This integration would provide a deeper insight into the underlying causes of crime and aid in developing more targeted and effective crime prevention strategies [68]. The research currently focuses on Selangor, Kuala Lumpur, and Putrajaya, Malaysia, limiting its comparative breadth. Including other regions with similar urban characteristics, both within Malaysia and internationally, could provide a more robust validation of our findings. Comparative analysis could highlight effective policing strategies and urban planning measures from different contexts, potentially offering actionable insights that could be applied to mitigate burglary rates in the studied regions and beyond [69]. These sources critique traditional methodologies for their inability to capture the evolving nuances of crime patterns over time.

6. Future Work

Future research should focus on dissecting the underlying causes behind the spatiotemporal patterns identified in this study. A multidisciplinary approach, integrating insights from criminology, urban planning, sociology, and psychology, is recommended to unpack the intricate interactions between human behavior, environmental factors, and crime rates [70]. Subsequent studies should evaluate the efficacy of diverse crime prevention methodologies, using advanced analytical tools to measure their impact on burglary rates across various times and locations. Furthermore, the potential of emerging technologies like predictive analytics and artificial intelligence in crime detection and prevention merits exploration, aiming to foster innovative solutions for urban safety [71]. The overarching aim of future work should be to formulate evidence-based, adaptable strategies that are capable of responding to the dynamic nature of urban environments and societal shifts, thus ensuring the sustained safety and welfare of communities globally [72].

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