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Research article

Criminological Insights: A Comprehensive Spatial Analysis of Crime Hot Spots of Property Offenses in Malaysia's Urban Centers

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Abstract

This study examines property crime trends in Selangor, Kuala Lumpur, and Putrajaya from 2015 to 2020, utilizing Geographic Information Systems (GIS) and comprehensive crime data from the Royal Malaysia Police. It focuses on the relationship between property crime rates and the delineation of police station jurisdictions across Selangor State, Kuala Lumpur Federal Territory (KLFT), and Putrajaya Federal Territory (PFT). The objective is to understand the dynamics of property crime, its evolution, and the influence of the National Transformation Program on crime prevention strategies. By assessing the spatial distribution of property crimes, this research aims to identify underlying trends and the efficacy of hot spot policing. The analysis is underpinned by an extensive review of secondary data from the Intelligence/Operations/Records Division of the Royal Malaysia Police Headquarters, enabling a deep dive into the spatial characteristics of property crime within these regions. The findings contribute to the broader understanding of crime prevention in Malaysia, underscoring the importance of GIS technology and the need for strategic interventions tailored to specific crime patterns. This study provides critical insights for policymakers and law enforcement to formulate evidence-based strategies, enhance public safety, and inform future crime prevention efforts.

Keywords: crime hotspot mapping; property crime trends; spatial analysis; Geographic Information Systems.

1. Introduction

Property crime rates exhibit significant variability across countries and regions, influenced by a complex interplay of factors. Since the 1990s, a notable decline in property crimes has been observed in many countries, a trend potentially linked to improved security measures, heightened community policing efforts, and demographic shifts, such as an aging population. For instance, a comprehensive study documented a substantial reduction in various property crimes in the United Kingdom between 1995 and 2004. Similarly, Kivivuori & Salmi (2006) reported decreased property crimes perpetrated by young individuals in Finland during the same timeframe. These findings are corroborated by data from the FBI's Uniform Crime Reporting (UCR) program, which indicated a significant decline in the estimated number of property crimes in the United States from 8,024,115 in 2015 to 6,925,677 in 2019 (FBI UCR, 2019). Notably, the FBI data from 2000 also reveals that the peak age for property crime arrests in the US is 16 years, in contrast to 18 years for violent crime arrests.

Crime prevention strategies frequently involve collaboration between law enforcement agencies and local authorities. In Malaysia, the Royal Malaysia Police (RMP) partners with Town Councils (TC) to leverage Geographic Information Systems (GIS) in identifying crime hotspots, termed "crime-prone areas" (Nordin & Saad, 2010). This approach aligns with the principles of "Community Policing," which emphasizes strengthening the relationship between the police force and the community. This study zeroes in on Selangor, Kuala Lumpur, and Putrajaya, employing GIS to investigate the correlation between property crime rates and the boundaries of police station jurisdictions. Its goal is to dissect the complexities of property crime in these areas and trace its evolution over time. Historical data reveal a significant upsurge in property crime and violence in Malaysia from 1980 to 2004, marking a 120% increase. However, the subsequent decade (2007-2017) witnessed a notable decline, largely attributed to the implementation of the National Transformation Program in 2010, which introduced a series of social programs and proactive policies (Jubit *et al.*, 2022; Hakim *et al.*, 2022). The National Key Result Areas (NKRAs), focusing on

crime reduction, anti-corruption, and improvement in living standards, are believed to have significantly contributed to the reduction in property crime rates.

Despite advancements in crime recording technologies, unreported crimes create a discrepancy between official data and the actual crime levels, underscoring the necessity for continuous research and the development of robust prevention strategies. This discrepancy highlights the challenge of comprehensively understanding criminal activity, compounded by underreporting and the significant variance between recorded crimes and actual incidents (Jansson, 2008; Hakim *et al.*, 2022). Moreover, the effectiveness of crime prevention measures, including policing and the broader criminal justice system, plays a crucial role in shaping public confidence in government actions (Abd Karim, 2015; Hakim *et al.*, 2022; Sidhu, 2005). This research is dedicated to examining property crime patterns in Malaysia, specifically within Selangor, Kuala Lumpur, and Putrajaya, from 2015 to 2020, and assessing the impact of national crime prevention initiatives implemented since the inception of the National Transformation Program in 2010 (Hakim *et al.*, 2022; PEMANDU, 2010; Shamsudin, 2008; Shamsudin *et al.*, 2013; The Star Online, 2011).

Addressing a critical need for a deeper understanding of the dynamics of property crime within Selangor State, Kuala Lumpur Federal Territory (KLFT), and Putrajaya Federal Territory (PFT) from 2015 to 2020, this research is motivated by two primary concerns. First, the discrepancies between officially reported crimes and actual occurrences due to underreporting necessitate a more thorough comprehension of property crime trends. Secondly, there is a research gap concerning the effectiveness of hot spot policing in specifically targeting and mitigating property crime hot spots. To navigate these issues, the study is framed around three main objectives: (i) to dissect the nuances of property crime within the specified regions, (ii) to evaluate the impact of the National Transformation Program initiated in 2010 on crime prevention efforts, and (iii) to scrutinize patterns of property crime rates and the effectiveness of national crime prevention initiatives introduced since 2010.

2. Research Methods

2.1 Study Area

The study focuses on the geographically contiguous and politically significant regions of Selangor State, Kuala Lumpur Federal Territory (KLFT), and Putrajaya Federal Territory (PFT) within Malaysia (Figure 1). These areas form a critical nexus in the Malaysian geopolitical landscape, with Selangor, the most populous state, encircling KLFT on three sides and serving as a hub of economic activity, particularly in the industrial and service sectors. Selangor is known for its wealth and hosts several tourist attractions, including the Blue Mosque, Sunway Lagoon Theme Park, and Batu Caves. KLFT, the heart of Malaysia, is celebrated for its modern architectural wonders, vibrant nightlife, and expansive shopping districts, home to the Petronas Twin Towers and Bukit Bintang commercial area, among others. PFT, envisioned as a modern urban center, functions as the administrative heart of the country and is strategically located between KLFT and Selangor. It is characterized by its innovative architecture, green spaces, and government landmarks such as the Putra Mosque and Lake Putrajaya (Ahmad *et al.*, 2024a, 2024b; Jubit *et al.*, 2023a).

2.2. Spatial and Aspatial Data

Embarking on a quantitative exploration, this study meticulously utilizes a vast array of detailed secondary data covering 2015 to 2020. This data, meticulously sourced from the Intelligence/Operations/Records Division of the Royal Malaysia Police Headquarters, forms the bedrock of our analysis, diving deep into the urban fabric of Selangor, KLFT, and PFT to examine the interplay between property crime incidents and their spatial characteristics. The investigation meticulously parses through data, including specific incident addresses, temporal patterns, and types of offences, to glean insights into the complex nature of property crime dynamics within these regions. With a keen eye on the demographic and strategic importance of Selangor, KLFT, and PFT, this study delineates police station (PS) boundaries within the Selangor Contingent Police Headquarters (SCPH), which includes 87 Police Stations and the 24 Police Stations under the Kuala Lumpur Contingent Police Headquarters (KLCPH). Employing sophisticated ArcGIS 10.8.2 software, the study aggregates and spatially maps the collected data against the backdrop of PS boundaries, offering a detailed view of crime distribution patterns across these vital urban areas (Ahmad, 2015; Ahmad *et al.*, 2011, 2013, 2015; Ahmad *et al.*, 2024c; Ahmad & Masron, 2013; Ariffin *et al.*, 2024; Basiron *et al.*, 2014; Jubit *et al.*, 2023b; Marzuki *et al.*, 2023; Ayob *et al.*, 2013, 2014; Zakaria *et al.*, 2023). This approach situates Selangor, KLFT, and PFT as dynamic urban centers within Malaysia, underscored by a robust law enforcement framework comprising a total of 111

Police Stations across the SCPH and KLCPH, highlighting the strategic and operational significance of these regions in the broader context of national security and public safety.

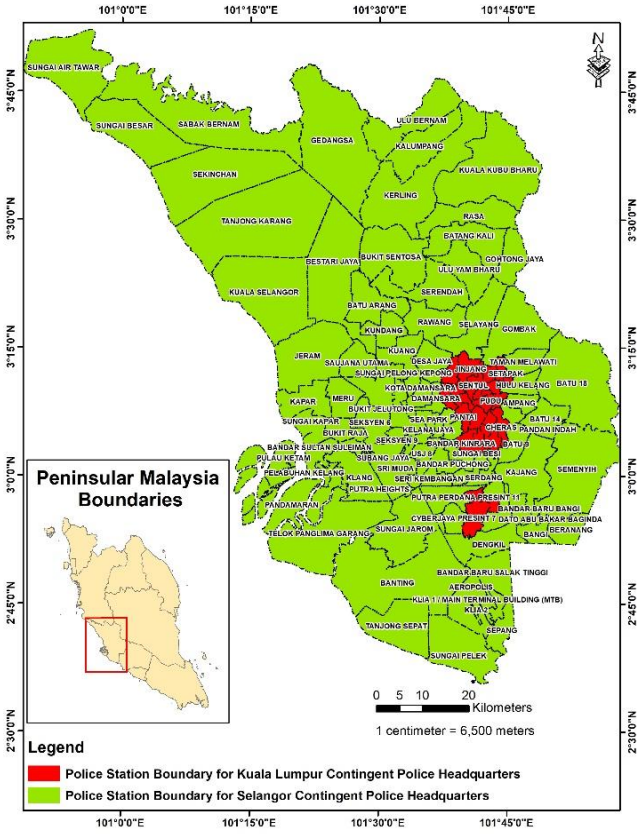

Figure 1. Police Stations Boundary for Selangor (SCPH) and Kuala Lumpur Contingent Police Headquarters (KLCPH) (Source: Data Collection/Analysis Division, Crime Prevention and Community Safety Department (CPCSD), Royal Malaysia Police Headquarters, Bukit Aman).

2.3. Global Moran's I (Spatial Autocorrelation)

Building on the foundational work of Ariffi (2022) and Mohamad Rasidi *et al.* (2013), Moran's Index is determined through a meticulous comparison of incident values within a specified area against those in neighboring regions, culminating in the calculation of the data's average. The Moran Index values, expressed in z-score units (standard deviations), alongside corresponding p-values, provide a robust framework for interpreting spatial data distributions. The index spans from +1, symbolizing maximum positive spatial autocorrelation (SA) or clustering of incidents, to -1, denoting utmost negative spatial autocorrelation or dispersion of incidents. A p-value less than 0.05, in conjunction with a significant z-score, underscores the existence of spatial autocorrelation, compelling the rejection of the null hypothesis (Jubit *et al.*, 2020). The calculation of Moran's Index involves a rigorous comparison of incident values within predefined spatial units against those in neighboring regions. This comparison yields a z-score, representing the number of standard deviations by which the observed spatial pattern deviates from randomness, along with a corresponding p-value. Despite its efficacy in quantifying overall spatial autocorrelation, the Global Moran's I statistic does not provide insights into localized clustering patterns within specific areas. To address this limitation and identify significant local clusters of crime incidents, the Getis-Ord Gi* statistic is employed. This local spatial autocorrelation technique complements the Global Moran's I analysis by pinpointing areas with statistically significant clustering or dispersion of crime incidents.

Nevertheless, this approach does not extend to pinpointing specific clustering areas or spatial patterns within particular locales. To bridge this gap, the Getis-Ord Gi* method is applied to examine local indices, shedding light on the tendency towards local spatial aggregations and demarcating zones with notable interspatial relationships (Ariffin, 2022). Within this analytical scope, spatial autocorrelation (SA) serves as a pivotal tool for identifying patterns in property crimes and violence, employing spatial statistical techniques to explore the proximity and similarities among subjects. This method is instrumental in revealing whether spatial patterns are clustered, dispersed, or randomly distributed, examining the likeness between observations at disparate spatial

locations, with variables categorized as either exogenous or endogenous (ESRI, 2022b). Moran's Index, anchoring the SA analysis, quantifies the correlation strength among entities within a spatial setting, with values ranging from I = -1 to +1 (Figure 2), facilitating a comprehensive assessment of the Global Moran's I Index through the calculation of its value, z-scores, p-values, and other pertinent metrics (Moran, 1950).

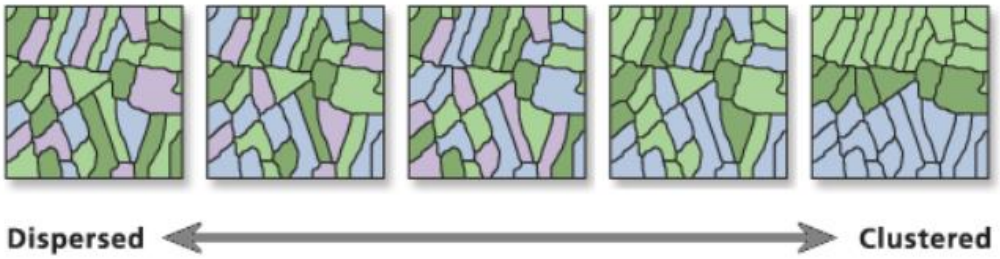

Figure 2. Spatial autocorrelation (SA) (Source: ESRI, 2022b).

The calculation of spatial autocorrelation according to Moran's I statistic is expressed as Equation 1. Zi is the attribute deviation for feature i from the mean (xi-X), wij is the spatial weight between feature i and j, n is equal to the total number of features, and S0 is the aggregate of all spatial weights (Equation 2). Subsequently, the z-score calculation for Moran's I Statistic is presented as Equation 3. In Equation 3, E[I] represents the expected value of Moran's I statistic (Equation 4), and V[I] denotes the variance of Moran's I statistic (Equation 4). In spatial analysis, sample variance, denoted as s2, plays a crucial role in understanding the variability or dispersion of a variable y across different locations. Here, y represents the value of a specific variable at a given location. The indices i and j denote different spatial units across geographical space, such as points or polygons. The overall mean of the variable across all locations is represented by $\bar{y}$, while $\bar{y}i$ signifies the mean value of the variable within a specific location i. The term Wij is the weighted location index that quantifies the spatial relationship between the units i and j, emphasizing the importance of proximity and spatial interaction among them. Finally, n denotes the total number of spatial units considered in the analysis, such as points or polygons, providing a count of the geographical entities under study. This framework is essential for spatial data analysis, enabling the examination of patterns, trends, and relationships across different locations, which are presented in equations 1,2,3,4 and 5.

$$I = \frac{n}{S_0}\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{i,j}Z_iZ_j}{\sum_{i=1}^{n} Z_i^2} \quad (1)$$

$$\bar{S_0} = \sum_{i=1}^{n}\sum_{j=1}^{n} W_{i,j} \quad (2)$$

$$z_I = \frac{I - E[I]}{\sqrt{V[I]}} \quad (3)$$

$$E[I] = -1/(n-1) \quad (4)$$

$$V[I] = E[I^2] - E[I]^2 \quad (5)$$

In summary, the Global Moran's I statistic, augmented by the Getis-Ord Gi* method, serves as a robust analytical framework for discerning the spatial patterns of property crime and violence within the study area. By meticulously examining the spatial relationships among crime incidents, this methodology facilitates a comprehensive understanding of the geographical distribution of crime and informs targeted interventions for crime prevention and law enforcement. These equations facilitate the calculation of Moran's I statistic and its associated z-score, enabling the assessment of spatial autocorrelation and the identification of significant spatial patterns in property crime within Selangor, Kuala Lumpur, and Putrajaya. Moran's I index is used to identify cases of property crime in Selangor, Kuala Lumpur and Putrajaya scattered randomly or not.

2.4. Hot Spot Analysis Statistic (Getis-Ord Gi*)

The Hot Spot Analysis, empowered by Geographic Information System (GIS) technology, is pivotal in identifying regions marked by a high incidence of criminal activities. This analytical method is invaluable to law enforcement and urban planning professionals, offering critical insights for pinpointing areas of high risk and devising targeted intervention strategies. Despite its

proven utility in uncovering geographic patterns of crime, it is crucial to recognize the method's limitations, notably its reliance on the accuracy of crime data and the exclusion of significant social and economic determinants impacting criminal behavior. An analysis that transcends mere spatial concentrations is warranted to achieve a holistic grasp of crime dynamics.

Echoing the insights of Chainey & Ratcliffe (2013); Gorr & Kurland (2012), the Getis-Ord Gi* statistic stands out as a robust analytical tool in crime analysis and mapping. Esteemed for its analytical precision, this tool enables crime analysts to effectively delineate geographic patterns of crime occurrences. A vital component of this methodology is the interpretation of z-score outcomes, which facilitates the identification of statistically significant hot and cold spots (Chainey & Ratcliffe, 2005; Gorr *et al.*, 2018; Hashim *et al.*, 2019). The Hot Spot Analysis tool calculates the Getis-Ord Gi* statistic for each dataset feature, with the resulting p-value and z-Score illuminating the spatial distribution of features with significantly clustered values. However, for a feature to qualify as a statistically significant hot spot, it must exhibit high values and surrounded by other features with comparably high values (ESRI, 2022a). The local Getis-Ord statistical formula underpins this analytical process, enabling a detailed and statistically sound interpretation of crime distribution patterns, thereby underscoring the importance of spatial context and clustering in augmenting the analysis's relevance and reliability. Where xj is the attribute value for feature j, wij is the weight of the space between features i and j, n is equal to the total number of features (Equation 7).

$$G_i^* = \frac{\sum_{j=1}^{n} W_{i,j} X_j - \bar{x} \sum_{j=1}^{n} W_{i,j}}{S \sqrt{\frac{\left[n \sum_{j=1}^{n} W_{i,j}^2 - \left(\sum_{j=1}^{n} W_{i,j} \right)^2 \right]}{n-1}}} \quad (6)$$

$$\bar{x} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (7)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{x})^2} \quad (8)$$

The G_i^* statistic is a z-score, so no further calculations are required (ESRI, 2022b; Muhamad Ludin *et al.*, 2013). This statistical formula facilitates the calculation of the Getis-Ord Gi* statistic for each dataset feature, enabling the identification of statistically significant hot spots based on their spatial distribution of values. By considering both the magnitude of feature values and their surrounding spatial context, this methodology provides a robust framework for understanding and interpreting patterns of crime distribution within the study area.

3. Results and Discussion

3.1. Global Moran's I (Spatial Autocorrelation)

The Moran's index analysis, spanning from 2015 to 2020, across Selangor, Kuala Lumpur, and Putrajaya regions, unveils significant insights into the spatial autocorrelation of property crime incidents. This comprehensive evaluation reveals a pronounced positive autocorrelation, indicating a tendency to cluster property crimes within these areas. The year 2019 noted the lowest Moran's index value at 0.114476, contrasting with 2018, which recorded the highest at 0.296870, highlighting a variable but distinctly clustered pattern of property crimes across the years. The analysis further revealed significant z-scores, ranging from 5.331402 to 13.219273, with accompanying p-values steadfastly at 0.00 across the study period, underscoring the statistical significance of these spatial patterns. The positive autocorrelation suggests a non-random spatial distribution of property crimes, pointing towards specific areas of heightened criminal activity. This clustering phenomenon within the study areas implies potential underlying socioeconomic, demographic, or environmental factors that necessitate deeper exploration. For law enforcement, policymakers, and urban planners, understanding these spatial dynamics is crucial for allocating resources efficiently and formulating targeted crime prevention strategies.

3.2. Hot Spot Analysis Statistic (Getis-Ord Gi*) by Year

The preliminary findings in Table 1 reveal a heterogeneous distribution of property crime occurrences, with significant clustering in certain geographic locales from 2015 to 2020. This period's spatial analysis, leveraging the Getis-Ord Gi* method, elucidates the intensity and persistence of spatial anomalies, namely hot and cold spots, offering nuanced insights into the evolving patterns of crime (Anselin, 1988; Anselin *et al.*, 2000). The analysis highlighted pronounced hot spots

marked by elevated Z-scores, indicating regions with a higher frequency of property crime incidents. Specifically, Z-scores fluctuated from 1.462194 to 4.856669 in 2015 and reached 5.620326 in 2018, showcasing a variable yet significant concentration of property crimes within these years.

Table 1. Global spatial autocorrelation for property crime polygons/areas from 2015 to 2020 in the States of Selangor, KLFT and PFT.

Year	Moran Index	Z-Score	P-Value	Pattern
2015	0.154382	7.09000543248	0.000000	Clustered
2016	0.201601	9.131412	0.000000	Clustered
2017	0.213371	9.576068	0.000000	Clustered
2018	0.296870	13.219273	0.000000	Clustered
2019	0.114476	5.331402	0.000000	Clustered
2020	0.118390	5.497333	0.000000	Clustered
2015-2020	0.208923	9.397954	0.000000	Clustered

Table 2. Z Score Hot Spot for the year 2015 until 2020

No.	Year	Z Score
1.	2015	1.462194 - 4.856669
2.	2016	1.456308 - 5.127389
3.	2017	2.384383 - 5.258847
4.	2018	1.803370 - 5.620326
5.	2019	1.680464 – 4.673705
6.	2020	1.689775 – 4.521312
7.	2015-2020	1.845707 - 5.203145

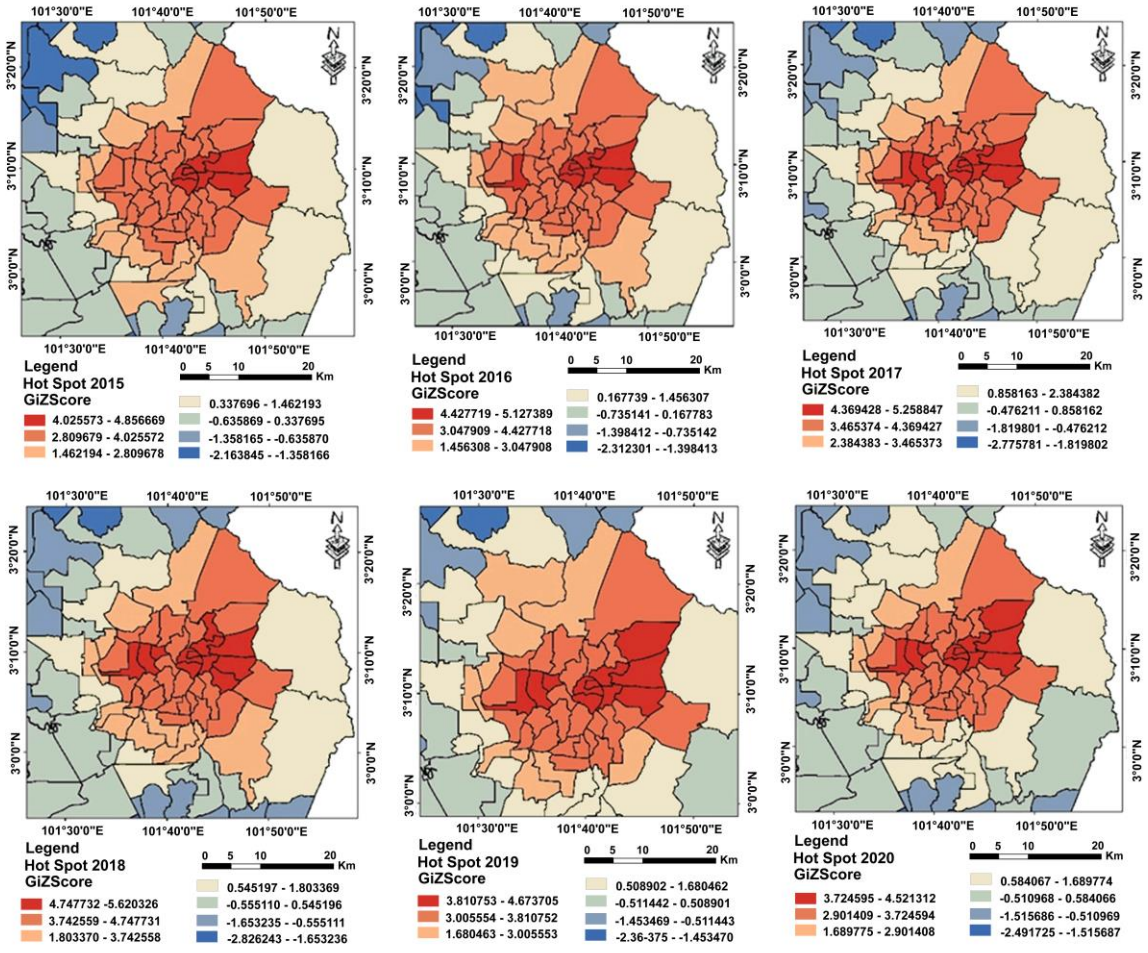

Figure 3. Analysis of spatial clustered (hot spot area) year 2015 to 2020 according to property crime polygon/area.

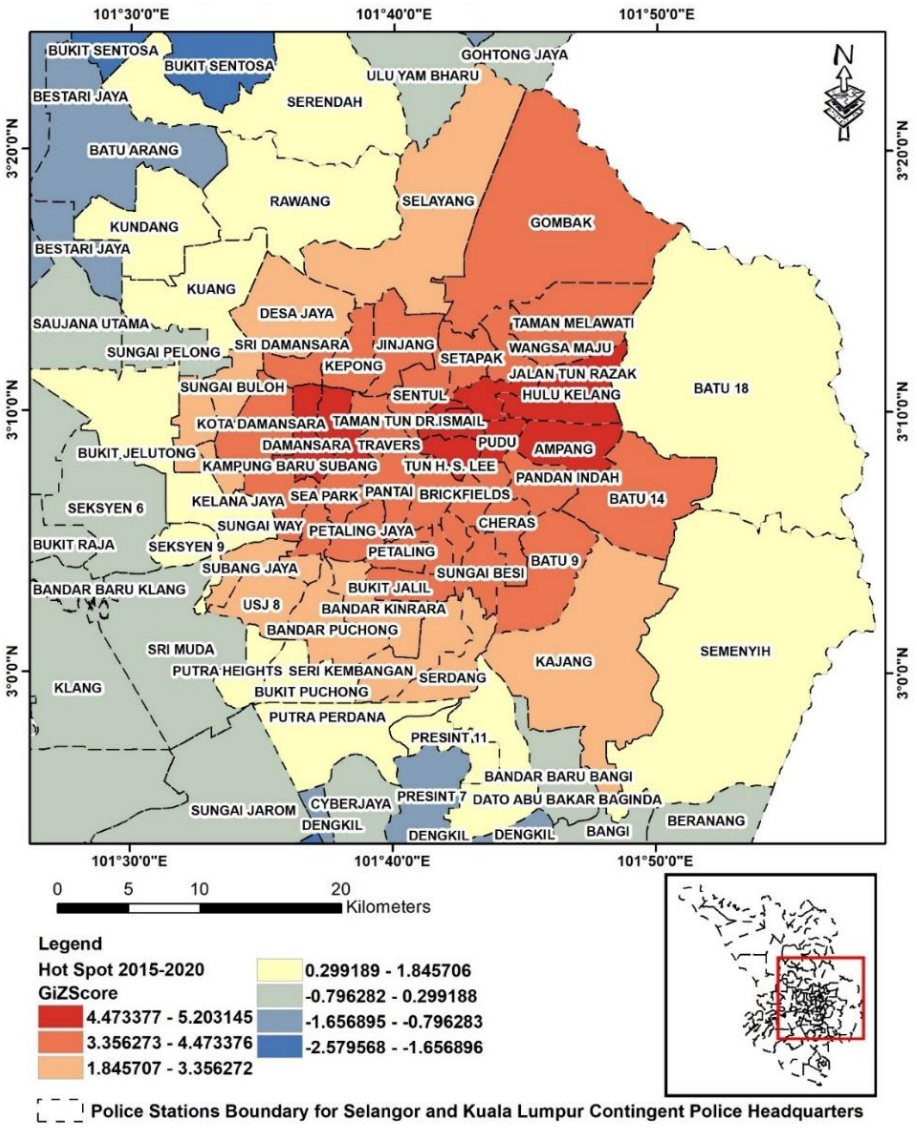

Figure 4. Analysis of spatial clustered (hot spot area) of 2015 to 2020 according to polygon/area based on the overall report of property crime cases.

The average Z-score across this span underscores the persistent nature of these hot spots within the Kuala Lumpur Federal Territory (KLFT) and its peripheral regions, correlating with observations within the Selangor Contingent Police Headquarters (SCPH) jurisdiction. These findings illuminate the spatial distribution of property crimes, highlighting areas where law enforcement efforts could be intensified. Notably, the central urban zones, including 111 police stations delineated in Figures 3 and 4, emerged as critical points for property crime concentration, emphasizing the necessity for targeted policing and strategic resource deployment for effective crime prevention and control.

The implications of these findings are multifaceted, serving as a pivotal resource for law enforcement agencies and policymakers in crafting and implementing public safety and crime prevention strategies. Identifying hot spot areas allows for strategically allocating resources and interventions to curtail property crime incidence effectively. Furthermore, this spatial analytical framework offers a robust foundation for proactive policing strategies, enabling a dynamic deployment of resources to preemptively address and mitigate potential crime escalations in identified vulnerable zones. The spatial analytical exploration of property crime incidents over the designated period has yielded critical insights into the distribution and clustering of crime, emphasizing the strategic importance of identifying and addressing hot spot areas. These insights facilitate a more informed and targeted approach in law enforcement and public safety initiatives, enhancing the overall efficacy of crime prevention measures. As we move forward, integrating spatial analysis into law enforcement practices promises to significantly bolster the capacity of agencies to identify, understand, and respond to emerging crime patterns, ultimately fostering safer communities and advancing public safety and crime prevention objectives.

3.3. Hot Spot Analysis Statistic (Getis-Ord Gi*) By Police Station Sum

The Hot Spot Analysis Statistic (Getis-Ord Gi*), applied to aggregate police station data from 2015 to 2020, identifies significant areas of property crime concentration within the jurisdictions of the Kuala Lumpur Contingent Police Headquarters (KLCPH) and the Selangor Contingent Police Headquarters (SCPH). Specifically, the KLCPH region, with 22 police stations, and the SCPH, peaking at 30 stations in 2019 and 2020, exhibit notably high property crime rates, delineating these areas as critical hot spots. This intensive analysis, represented in Table 3 and visualized in Figures 3 and 4, offers a detailed view of property crime distribution and its spatial clustering within Selangor, Kuala Lumpur, and Putrajaya. From an initial overview of 50 police station boundaries in 2015-2016 to a nuanced examination of 48 to 52 stations in subsequent years, the study portrays a dynamic yet consistent pattern of property crime occurrences across these regions. The KLCPH, despite its relatively small geographical area, has consistently emerged as a central node of property crime activity throughout the six years under review, potentially due to its high population density.

The spatial clustering identified within KLCPH and SCPH emphasizes the critical need for focused law enforcement strategies and the strategic allocation of resources to counteract the prevalence of property crime effectively. This pattern of consistent property crime incidence within KLCPH particularly highlights the necessity for interventions designed to tackle the unique challenges of urban density and complexity. The analytical findings underscore the importance of a targeted approach in law enforcement efforts, urging a strategic realignment towards areas identified as hot spots. By capitalizing on the insights derived from the spatial analysis, law enforcement agencies can enhance patrols, surveillance, and community outreach in regions marked by elevated property crime rates. Furthermore, the study advocates for strengthening inter-agency cooperation and sharing data to foster a coordinated and comprehensive response to the underlying causes of property crime hot spots.

The detailed examination of property crime across police station boundaries within Selangor, Kuala Lumpur, and Putrajaya has uncovered significant spatial clustering, with KLCPH notably identified as a recurrent hot spot. This persistent trend underscores the imperative for precise, targeted interventions and the judicious allocation of resources to address and mitigate property crime in these urban centers. The insights obtained from this analysis provide a solid foundation for developing evidence-based strategies to reduce property crime and enhance public safety in the highlighted hot spot areas, paving the way for future efforts to create safer, more secure communities.

Table 3. Hot spot and police station boundary.

No	Year	Kuala Lumpur	Selangor	Total
1	2015	22	28	50
2	2016	22	28	50
3	2017	22	29	51
4	2018	22	30	52
5	2019	22	26	48
6	2020	22	26	48
7	2015-2020	22	28	50

Table 4. Correlation between property crime hot spot areas and police station boundaries with 90% to 99% confidence levels.

NO.	Contingent Police Headquarters (CPH)	District Police Headquarters (DPH)	Police Stations (PS)	2015	2016	2017	2018	2019	2020	2015-2020
1	Kuala Lumpur	Brickfields	Balai Polis Brickfields	X	X	X	X	X	X	X
2	Kuala Lumpur	Brickfields	Balai Polis Pantai	X	X	X	X	X	X	X
3	Kuala Lumpur	Brickfields	Balai Polis Petaling	X	X	X	X	X	X	X
4	Kuala Lumpur	Brickfields	Balai Polis Sri Hartamas	X	X	X	X	X	X	X
5	Kuala Lumpur	Brickfields	Balai Polis Sri Petaling	X	X	X	X	X	X	X
6	Kuala Lumpur	Brickfields	Balai Polis Taman Tun Dr. Ismail	X	X	X	X	X	X	X
7	Kuala Lumpur	Brickfields	Balai Polis Travers	X	X	X	X	X	X	X

Table 4. Correlation between property crime hot spot areas and police station boundaries with 90% to 99% confidence levels (continued).

NO.	Contingent Police Headquarters (CPH)	District Police Headquarters (DPH)	Police Stations (PS)	2015	2016	2017	2018	2019	2020	2015-2020
8	Kuala Lumpur	Cheras	Balai Polis Bukit Jalil	X	X	X	X	X	X	X
9	Kuala Lumpur	Cheras	Balai Polis Cheras	X	X	X	X	X	X	X
10	Kuala Lumpur	Cheras	Balai Polis Salak Selatan	X	X	X	X	X	X	X
11	Kuala Lumpur	Cheras	Balai Polis Salak Selatan Baru	X	X	X	X	X	X	X
12	Kuala Lumpur	Cheras	Balai Polis Sungai Besi	X	X	X	X	X	X	X
13	Kuala Lumpur	Dang Wangi	Balai Polis Chow Kit	X	X	X	X	X	X	X
14	Kuala Lumpur	Dang Wangi	Balai Polis Dang Wangi	X	X	X	X	X	X	X
15	Kuala Lumpur	Dang Wangi	Balai Polis Tun H. S Lee	X	X	X	X	X	X	X
16	Kuala Lumpur	Sentul	Balai Polis Jinjang	X	X	X	X	X	X	X
17	Kuala Lumpur	Sentul	Balai Polis Kepong	X	X	X	X	X	X	X
18	Kuala Lumpur	Sentul	Balai Polis Sentul	X	X	X	X	X	X	X
19	Kuala Lumpur	Wangsa Maju	Balai Polis Jalan Tun Razak	X	X	X	X	X	X	X
20	Kuala Lumpur	Wangsa Maju	Balai Polis Pudu	X	X	X	X	X	X	X
21	Kuala Lumpur	Wangsa Maju	Balai Polis Setapak	X	X	X	X	X	X	X
22	Kuala Lumpur	Wangsa Maju	Balai Polis Wangsa Maju	X	X	X	X	X	X	X
23	Selangor	Ampang Jaya	Balai Polis Ampang	X	X	X	X	X	X	X
24	Selangor	Ampang Jaya	Balai Polis Hulu Kelang	X	X	X	X	X	X	X
25	Selangor	Ampang Jaya	Balai Polis Pandan Indah	X	X	X	X	X	X	X
26	Selangor	Ampang Jaya	Balai Polis Taman Melawati	X	X	X	X	X	X	X
27	Selangor	Gombak	Balai Polis Desa Jaya	X	X	X	X	X	X	X
28	Selangor	Gombak	Balai Polis Gombak	X	X	X	X	X	X	X
29	Selangor	Gombak	Balai Polis Rawang		X	X	X	X	X	X
30	Selangor	Gombak	Balai Polis Selayang	X	X	X	X	X	X	X
31	Selangor	Kajang	Balai Polis Batu 14	X	X	X	X	X	X	X
32	Selangor	Kajang	Balai Polis Batu 18			X	X			
33	Selangor	Kajang	Balai Polis Batu 9	X	X	X	X	X	X	X
34	Selangor	Kajang	Balai Polis Kajang	X	X	X	X		X	X
35	Selangor	Petaling Jaya	Balai Polis Damansara	X	X	X	X	X	X	X
36	Selangor	Petaling Jaya	Balai Polis Kelana Jaya	X	X	X	X	X	X	X
37	Selangor	Petaling Jaya	Balai Polis Kota Damansara	X	X	X	X	X	X	X
38	Selangor	Petaling Jaya	Balai Polis Lapangan Terbang Sultan Abdul Aziz Shah (LTSAAS)	X	X	X	X	X	X	X
39	Selangor	Petaling Jaya	Balai Polis Petaling Jaya	X	X	X	X	X	X	X
40	Selangor	Petaling Jaya	Balai Polis Sea Park	X	X	X	X	X	X	X
41	Selangor	Petaling Jaya	Balai Polis Sri Damansara	X	X	X	X	X	X	X
42	Selangor	Petaling Jaya	Balai Polis Sungai Way	X	X	X	X	X	X	X
43	Selangor	Sepang	Balai Polis Putra Perdana	X						
44	Selangor	Serdang	Balai Polis Seri Kembangan	X	X	X	X			X
45	Selangor	Serdang	Balai Polis Serdang	X	X	X	X			X

Table 4. Correlation between property crime hot spot areas and police station boundaries with 90% to 99% confidence levels (continued).

NO.	Contingent Police Headquarters (CPH)	District Police Headquarters (DPH)	Police Stations (PS)	2015	2016	2017	2018	2019	2020	2015-2020
46	Selangor	Serdang	Balai Polis Puchong	X	X	X	X	X	X	X
47	Selangor	Serdang	Balai Polis Bandar Kinrara	X	X	X	X	X	X	X
48	Selangor	Shah Alam	Balai Polis Seksyen 9				X			
49	Selangor	Subang Jaya	Balai Polis Bandar Sunway	X	X	X	X	X	X	X
50	Selangor	Subang Jaya	Balai Polis Subang Jaya	X	X	X	X	X	X	X
51	Selangor	Subang Jaya	Balai Polis USJ 8	X	X	X	X	X	X	X
52	Selangor	Sungai Buloh	Balai Polis Kampung Baru Subang	X	X	X	X	X	X	X
53	Selangor	Sungai Buloh	Balai Polis Sungai Buloh	X	X	X	X	X	X	X

3.4. Hot Spot Analysis Statistic (Getis-Ord Gi*) By Location

The detailed examination of property crime data across different locations revealed significant clusters, as indicated by elevated Z-scores. Particularly notable were the high Z-scores recorded within the Pantai Police Station Boundary (PSB) in 2015 and the subsequent peak in 2016 at Jalan Tun Razak PSB. This pattern continued with Ampang PSB in 2017, showcasing a trend of increasing Z-scores to 2020. These findings, consistent across six years, predominantly localize within the Kuala Lumpur Contingent Police Headquarters (KLCPH) and extend to several areas within the Selangor Contingent Police Headquarters (SCPH), emphasizing the enduring nature and significance of these hotspots. This consistent identification of hotspots, particularly those near police headquarters, suggests underlying correlations with demographic shifts, urban infrastructure developments, or socioeconomic factors that merit further exploration. The analysis provides law enforcement agencies and policymakers with crucial insights, enabling a strategic allocation of resources towards areas with heightened criminal activity to effectively mitigate crime rates and enhance public safety.

As deduced from the Z-scores, the presence of hotspots underscores the importance of a data-driven approach in crime prevention and law enforcement strategies. By applying spatial analysis techniques, authorities can focus their interventions on areas with significant crime concentrations, thereby maximizing the impact of their efforts and improving the overall effectiveness of crime reduction initiatives. Furthermore, identifying areas with consistently low Z-scores presents an opportunity for targeted community policing and proactive crime prevention, highlighting the potential for strategic interventions in areas deemed at lower risk. The Hot Spot Analysis Statistic (Getis-Ord Gi*) by Location offers valuable insights into the spatial distribution of property crime, identifying critical hotspots and areas of lower crime concentration. This analysis aids law enforcement in prioritizing efforts and resources, ensuring a targeted approach to crime prevention and public safety enhancement. Moving forward, the ongoing monitoring and analysis of crime data will be essential in adapting and evolving strategies to address changing patterns and emerging threats, aiming to create safer, more secure communities.

Table 5. The highest z score hot spot for midnight, morning, evening, and night from 2015 to 2020.

2015							
No.	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Kuala Lumpur	Brickfields	Pantai	4.85666937	1.19E-06	3	99%
2.	Kuala Lumpur	Brickfields	Brickfields	4.848412881	1.24E-06	3	99%
3.	Selangor	Gombak	Batu Arang	4.742396129	2.11E-06	3	99%
4.	Selangor	Sepang	Sungai Pelek	2.009975129	0.044434	2	95%

Table 6. The highest z score hot spot for midnight, morning, evening, and night from 2015 to 2020 (continued).

No.	Contingent Police Headquarters (CPH)	District Police Headquarters (DPH)	Police Station (PS)	GiZScore	GiPValue	Gi_Bin	Significant Level
5.	Selangor	Sepang	Dengkil	1.955417137	0.050534	1	90%
6.	Kuala Lumpur	Putrajaya	Presint 11	1.791110905	0.073275	1	90%
			2016				
No	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Kuala Lumpur	Wangsa Maju	Jalan Tun Razak	5.12738915	2.93788E-07	3	99%
2.	Kuala Lumpur	Dang Wangi	Tun H. S. Lee	5.058934727	4.21605E-07	3	99%
3.	Kuala Lumpur	Dang Wangi	Jalan Dang Wangi	5.017671199	5.23016E-07	3	99%
4.	Selangor	Subang Jaya	USJ 8	2.303987442	0.021223349	2	95%
5.	Selangor	Kajang	Kajang	1.99443191	0.046104874	2	95%
6.	Selangor	Gombak	Rawang	1.816214249	0.069337513	1	90%
			2017				
No	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Selangor	Ampang Jaya	Ampang	5.258847	1.45E-07	3	99%
2.	Kuala Lumpur	Dang Wangi	Jalan Dang Wangi	5.230781	1.69E-07	3	99%
3.	Kuala Lumpur	Dang Wangi	Tun H. S. Lee	5.192376	2.08E-07	3	99%
4.	Selangor	Kajang	Kajang	1.960516	0.049935556	2	95%
5.	Selangor	Gombak	Rawang	1.94463	0.051819514	1	90%
6.	Selangor	Kajang	Batu 18	1.795308	0.07260461	1	90%
			2018				
No	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Selangor	Ampang Jaya	Ampang	5.620326223	1.90597e-08	3	99%
2.	Kuala Lumpur	Wangsa Maju	Jalan Tun Razak	5.5384368	3.05183e-08	3	99%
3.	Kuala Lumpur	Dang Wangi	Jalan Dang Wangi	5.475483078	4.3632e-08	3	99%
4.	Selangor	Gombak	Rawang	1.803368638	0.07133034	1	90%
5.	Selangor	Kajang	Batu 18	1.759370283	0.078514636	1	90%
6.	Selangor	Shah Alam	Seksyen 9	1.696561087	0.089779672	1	90%
			2019				
No	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Selangor	Ampang Jaya	Ampang	4.67370513	2.95814e-06	3	99%
2.	Kuala Lumpur	Wangsa Maju	Jalan Tun Razak	4.503409882	6.68717e-06	3	99%

Table 7. The highest z score hot spot for midnight, morning, evening, and night from 2015 to 2020 (continued).

No.	Contingent Police Headquarters (CPH)	District Police Headquarters (DPH)	Police Station (PS)	GiZScore	GiPValue	Gi_Bin	Significant Level
3.	Kuala Lumpur	Dang Wangi	Jalan Dang Wangi	4.481679817	7.40578e-06	3	99%
4.	Selangor	Sungai Buloh	Kampung Baru Subang	2.198094026	0.027942406	2	95%
5.	Selangor	Gombak	Rawang	1.921554016	0.054661899	1	90%
6.	Selangor	Subang Jaya	Usj 8	1.68046217	0.092867429	1	90%
			2020				
No	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Selangor	Ampang Jaya	Ampang	4.521312	6.15e-06	3	99%
2.	Kuala Lumpur	Wangsa Maju	Jalan Tun Razak	4.40952	1.04e-05	3	99%
3.	Kuala Lumpur	Dang Wangi	Tun H. S. Lee	4.398311	1.09e-05	3	99%
4.	Selangor	Subang Jaya	Usj 8	1.689774	0.091071	1	90%
5.	Selangor	Kajang	Kajang	1.670275	0.094865	1	90%
6.	Selangor	Gombak	Rawang	1.654421	0.098042	1	90%
			2015-2020				
No	**Contingent Police Headquarters (CPH)**	**District Police Headquarters (DPH)**	**Police Station (PS)**	**GiZScore**	**GiPValue**	**Gi_Bin**	**Significant Level**
1.	Kuala Lumpur	Wangsa Maju	Jalan Tun Razak	5.203145031	1.95944E-07	3	99%
2.	Kuala Lumpur	Dang Wangi	Tun H. S. Lee	5.179093062	2.22967E-07	3	99%
3.	Selangor	Ampang Jaya	Ampang	5.162082869	2.44217E-07	3	99%
4.	Selangor	Serdang	Seri Kembangan	2.182617429	0.029063995	2	95%
5.	Selangor	Kajang	Kajang	2.046753612	0.040682282	2	95%
6.	Selangor	Gombak	Rawang	1.8457063	0.064934862	1	90%

3.2. Discussion

This study highlights a notable knowledge gap concerning the efficacy of hot spot policing in directly addressing and mitigating property crime hotspots. Despite the abundance of literature on crime prevention strategies, a focused examination in this realm remains sparse (e.g., Braga, 2003; Braga *et al.*, 2014, 2019; Duru & Akbas, 2021; Koper *et al.*, 2021; B. Taylor *et al.*, 2011; B. G. Taylor *et al.*, 2022). The employment of Geographic Information Systems (GIS) in mapping crime incidents and conducting hotspot analysis by several researchers (e.g., Han *et al.*, 2023; Mokhtar *et al.*, 2023) has yielded valuable insights into crime patterns, shaping future research methodologies. Additionally, studies by Nix *et al.* (2024) and Santos (2021) underscore the significance of proactive policing on neighborhood-level crime rates, emphasizing the necessity for understanding its impacts across various crime types, including property crimes, to craft evidence-based policies (Jubit *et al.*, 2020; Tavares & Costa, 2021).

The application of spatial analysis techniques and predictive modeling is posited to enhance crime prevention strategies and optimize resource distribution. The importance of temporal analysis in comprehending the dynamic nature of crime hotspots is highlighted by Jubit *et al.* (2020) and Han *et al.* (2023), while the amalgamation of GIS with advanced statistical methods in studies by Mokhtar *et al.* (2023) and Nepomuceno *et al.* (2019) demonstrates the instrumental role of technology in crime mapping and analysis. The potential for technological advancements to augment crime forecasting and hotspot identification is a promising avenue for future research. Furthermore, B. G. Taylor *et al.* (2022) have underscored the efficacy of community-infused problem-

oriented policing (CPOP) interventions in crime reduction, advocating for the engagement of community members in problem-solving efforts, particularly in marginalized areas.

The intricate interplay between different crime types within hotspots, as shown in studies by Shiode *et al.* (2023) and the specialization within property crime types documented by Felson *et al.* (2022), underscores the complexity of crime dynamics and the necessity for targeted interventions. These interventions should account for the distinct characteristics of each crime type and the social conditions fostering them. Research in varied contexts is imperative for evaluating the applicability of these findings and refining urban crime analysis methods. Ceccato & Wilhelmsson (2020) and Fenimor (2019) have explored the socioeconomic repercussions of crime hotspots, including their impact on property values and the spatial distribution of harm spots, further emphasizing the need for nuanced crime prevention strategies that address the socio-ecological processes underpinning crime patterns.

The implications of this research are manifold, spanning policy, practice, and further research. Policymakers and law enforcement must devise bespoke strategies to tackle the unique aspects of various crime hotspots, while urban development initiatives should consider the socioeconomic ramifications of crime hotspots on property values and neighborhood dynamics. A multidisciplinary approach, integrating geography, criminology, sociology, and urban planning, is essential for crafting comprehensive and effective crime prevention strategies. Ongoing research and data collection are crucial for advancing our understanding of crime patterns and supporting evidence-based policymaking. This research underscores the value of incorporating diverse methodologies and perspectives to deepen our comprehension of crime and devise targeted interventions. The interdisciplinary nature of property crime research, incorporating geography, criminology, statistics, and technology, facilitates the identification of research gaps and fosters the development of more effective crime prevention strategies and policies.

This study's analysis, focused on property crime incidents from 2015 to 2020 in Selangor, Kuala Lumpur, and Putrajaya, acknowledges several limitations that pave the way for future research opportunities. The selected timeframe, while offering valuable insights, may not encompass long-term trends or account for recent shifts in crime patterns. Extending the temporal scope in future studies could yield a richer understanding of the evolving dynamics of crime over a more extended period. Examining property crime clustering at a regional level might not adequately capture localized variations within the examined areas. Subsequent research could benefit from employing finer spatial resolutions or extending the geographic scope to improve the generalizability of the findings. Moreover, the accuracy, quality, and reliability of the utilized crime data could affect the study's outcomes, suggesting a need for future research to address potential reporting biases or inconsistencies through rigorous validation techniques or exploring alternative data sources.

While this research highlights spatial autocorrelation and hot spot detection, it does not extensively explore the underlying factors contributing to crime patterns. Incorporating socioeconomic, demographic, and environmental variables in future studies could provide deeper insights into the root causes of property crime clustering. Additionally, although methodological approaches like Moran's index and Getis-Ord Gi* statistics were employed, integrating advanced spatial analysis techniques or adopting complementary methodologies could further refine our understanding of crime spatiality. The study emphasizes the significance of spatial crime patterns for effective resource allocation and crime prevention. Future research endeavors should aim to translate findings into actionable policy recommendations, assessing the efficacy of targeted interventions in reducing property crime rates. Finally, acknowledging that property crime is influenced by a multitude of factors beyond traditional criminological frameworks—such as urban planning, economic development, and community dynamics—future interdisciplinary collaborations could enhance the analytical depth by incorporating diverse perspectives, offering a more holistic approach to addressing the complexities of property crime.

4. Conclusion

This comprehensive study, through the application of the Getis-Ord Gi* Hot Spot Analysis and Moran’s I Spatial Autocorrelation techniques, has identified significant spatial clustering of property crime within the Kuala Lumpur and Selangor regions, spanning from 2015 to 2020. The findings reveal a consistent pattern of crime hotspots, particularly within areas proximal to the Kuala Lumpur Contingent Police Headquarters (KLCPH) and the Selangor Contingent Police Headquarters (SCPH), underscoring the persistent nature of property crime concentration in these urban centers. Elevated Z-scores across specific police station boundaries, notably within KLCPH, highlight areas of heightened criminal activity, suggesting the need for targeted law enforcement interventions and resource allocation. The study's insights into the spatial distribution

and persistence of crime hotspots across the years offer valuable implications for law enforcement agencies and policymakers, advocating for a data-driven, strategic approach to crime prevention and public safety enhancement. This research provides a solid foundation for developing evidence-based strategies to reduce property crime and foster safer communities by pinpointing areas of significant criminal activity and identifying trends over time.

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Conflict of interest

All authors declare that they have no conflicts of interest.

Data availability

Data is not available, confidential and must get permission from the Malaysian government and the Royal Malaysian Police (RMP).

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