



A Spatial Analysis of Crime Trends and Solution Efficiency across Philippine Police Regional Offices

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ABSTRACT

Monitoring and analysis of crime trends is crucial for improving public safety and effective law enforcement, especially in a country which has a large geographic and socioeconomic diversity such as the Philippines. While past studies have demonstrated the value of hotspot mapping and spatial statistics in urban contexts, few studies have systematically addressed the inter-regional disparities in both crime incidence solution efficiency across regions using advanced spatial analysis. This study seeks to fill this gap through spatial-statistical techniques such as hotspot mapping, Global Moran's I, Spatial Lag Modeling, and spatial scan statistics on crime data from the Philippines for a period from January 2022 to September 2023. The analysis showed a high spatial clustering of reported crimes in highly urbanized areas like the NCR, CALABARZON, and Central Visayas. Spatial regression identified unemployment, population, and the number of police stations as significant factors influencing reported crime cases. The spatial clustering highlighted regions with low-risk that had significantly a smaller number of crime cases than expected. The study's findings underscore the need for prioritizing resources in high-crime urban regions, enhancing community policing and inter-agency coordination, and investing in education and employment opportunities. Finally, the study recommends future research at finer geographic and temporal levels for more refined policy development.

Keywords: Crime trends; Spatial analysis; Hotspot mapping; Global moran's I; Spatial lag modelling

1. Introduction

Crime constitutes an act or omission which violates a criminal law and is punishable by the state by any number of sanctions including fines, incarceration and community service [1]. Crime includes a wide array of behaviors such as violent crimes, property crimes, and organized crimes, that violate public safety and social order. Criminal behavior is rooted in the interaction of individual characteristics, social processes, and environmental opportunities indicating the need for multilevel prevention and enforcement response [2].

Tracking crime patterns is crucial, as it indicates the state of public safety and the extent to which communities, families, and individuals are vulnerable to crime [3, 4] and police report data and crime mapping methods can be an effective means of identifying where crimes occur [5]. Crime monitoring also provides valuable insights into patterns and causes of criminal activity, informing targeted interventions, and regular tracking of crime rates helps policymakers allocate resources efficiently, enhancing community safety and crime prevention efforts [6].

Keeping an eye on crime is a fundamental process by which nations and communities seek to maintain safety for citizens, as well as social order. Crime is not just about a concrete cost — it is also about the broader social, economic, and emotional consequences for individuals and communities [7, 8]. A proper crime monitoring system allows us to understand the locations of concern and utilize appropriate remedial strategies. This provides an opportunity to minimize the wasted use of resources and consider longer term strategies to reduce the incidence of crime and the associated negative consequences [9, 10]. As the cities grow and become more complex, there is no doubt that the need for evidence-based solutions has become increasingly critical. This is why

various regions, countries, and some organizations invest in better surveillance to stay ahead of crime trends [11].

In the context of the Philippines, the challenge of crime monitoring and reduction is multifaceted, reflecting the archipelago's diverse geography, socio-economic disparities, and evolving criminal landscape. According to recent national reports from [12], crime rates exhibit considerable variability across regions, with urban centers such as Metro Manila experiencing higher incidences of property-related and violent crimes, while rural and peri-urban areas face their own distinctive patterns of illegal activity, including drug trafficking, environmental crimes, and interpersonal violence. The heterogeneity of crime rates in the Philippines is primarily attributed to structural issues such as geography, an uneven distribution of resources, historical policy constructs giving rise to certain preference over other regions, and unequal access to markets. The Philippine case presents a valuable case study for examining the spatial dimensions of crime and law enforcement effectiveness [13].

Despite advances in crime data systems and geographic information technologies, several institutional challenges remain. Differences in reporting standards, inconsistencies in data collection, and limited inter-agency coordination complicate efforts to develop an integrated understanding of crime trends and police performance [14]. Moreover, while spatial analysis tools are increasingly available, translating analytical findings into policy action requires sustained organizational support and technical capacity within law enforcement agencies and local government units [15]. Understanding these challenges have a great impact in the researcher's ability to bridge the gap between their own academic work to produce tangible and meaningful outcomes with respect to

crime prevention and law enforcement, which is a key part of this research.

Spatial analysis is significant in crime research because criminal activity is not randomly distributed across space but it tends to cluster in identifiable locations. [16] demonstrated that crime concentrates at specific “hot spots,” highlighting the importance of geographic targeting. Similarly, [17] introduced spatial autocorrelation techniques that allow researchers to detect statistically significant clustering patterns. Crime pattern theory proposed by [18] further emphasizes the role of environmental structure in shaping crime distribution and empirical evidence consistently shows that spatially informed approaches improve the identification of high-risk areas and enhance resource allocation efficiency [19, 20].

Previous spatial crime studies have primarily focused on localized urban settings in the Philippines. For instance, [21] conducted a spatial analysis of violent crimes in Metro Manila, emphasizing hotspot identification in densely populated urban areas. Similarly, Leikuma-Rimicane [22] examined the spatial distribution and types of crimes in selected localities, providing valuable insights into crime characteristics at the subnational level. Although these studies provide valuable insights in the local context, there is still limited attention to geographical and comprehensive comparison across all Philippine Police Regional Offices (PROs). To date, there is still a lack of spatial analysis at the national level that integrates hotspot mapping, spatial autocorrelation, spatial regression modeling, and spatial scan statistics to simultaneously assess both crime distribution and police performance across all 17 Police Regional Offices (PROs).

Existing crime mapping and spatial regression studies both in the Philippines and internationally usually focus on either crime incidence or socioeconomic correlates within specific cities or regions. There remains a limitation in national-level research that integrates multiple spatial analytical

techniques while simultaneously examining both crime distribution and solution efficiency indicators.

To address this gap, this study advances the literature by providing a comprehensive spatial comparison across all 17 Philippine PROs by moving beyond city-level case studies. It integrates hotspot mapping, spatial autocorrelation, spatial regression modeling, and spatial scan statistics within a single national-level framework and examines crime incidence and solution efficiency by observing patterns of crime concentration. Beyond descriptive mapping, the study identifies the socioeconomic and infrastructural factors that contribute to regional disparities in crime incidence and solution efficiency. PRO-level analysis is theoretically meaningful as it corresponds to the operational structure of the PNP. This research will provide actionable insights for policymakers, police administrators, and community stakeholders to inform resource allocation and policy interventions.

2. Methodology

2.1 Data description and source

The data employed in this study were obtained from several official sources. Crime incident and crime solved records were obtained from the Philippines National Police (PNP) for monthly data records from January 2022 to September 2023. In addition, socioeconomic and demographic information were collected from Philippine Statistics Authority and the World Bank. To determine the area where PNP offices are located, a regional shapefile was used to map and evaluate the geographic trends which was obtained from the Humanitarian Data Exchange (HDX) website (<https://data.humdata.org/>). In terms of data management, all data sets were harmonized and geographically integrated using Geographic Information Systems (GIS), a software application for spatial data analysis.

2.2 Study area and variables

The study considered 17 PROs located in different parts of the Philippines, which served as the primary administrative units of the Philippine National Police (PNP). The Philippines is one of the countries in Southeast Asia that is located in the western Pacific Ocean. The country consists of over 7,000 islands and is divided into three major island groups—Luzon, Visayas, and Mindanao. Each PRO is responsible for law enforcement and crime prevention within its covered jurisdiction which covers multiple provinces and highly urbanized cities.

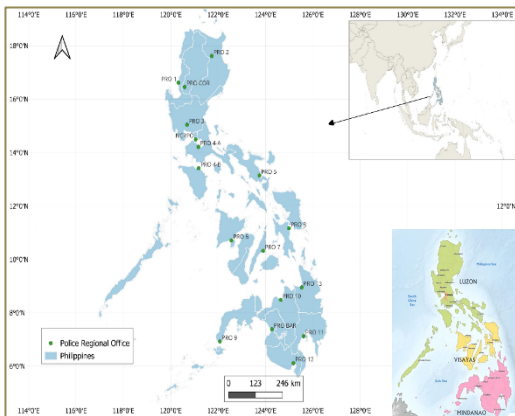


Fig. 1. Geographic Distribution of Philippine National Police Regional Offices.

The study focused on examining the spatial distribution and determinants of crime incidents across regions in the Philippines. These variables were chosen based on their potential influence on regional crime patterns.

Table 1. Description of Variables Used in the Spatial Analysis.

Variable	Description
Crime Incidents	Reported crime cases within each region include Peace and Order Indicators such as the eight focus crimes (e.g., murder, robbery, theft) and special complex crimes, and Public Safety Indicators like reckless imprudence resulting in homicide, injury, or property damage.

Solved Crime	The total number of crime cases that were resolved indicating a more complete resolution of the incident.
Police Stations	Represents the total number of police stations within each region.
Inflation Rate	Measured as a percentage (%) that reflects the rate at which the general level of prices for goods and services is rising.
Educational Attainment	Measures the proportion of the population who have completed at least high school education.
Unemployment Rate	Reflects the proportion of the able-bodied workforce that is without jobs.
Population	Total number of people residing within a specific region or jurisdiction.
Poverty Rate	The percentage of the population living below the poverty line.

In this study, solution efficiency refers to the crime clearance and solution rate that are officially reported by the Philippine National Police (PNP) and it is measured by the proportion of recorded crime incidents that are resolved through the identification of suspects and the filing of appropriate charges within a given period. Solution efficiency is calculated as,

$$\text{Solution Efficiency} = \frac{\text{No. of Solved Cases}}{\text{Total No. of Reported Cases}} \times 100.$$

This metric is widely used in criminological research as an indicator of police performance since it reflects investigative effectiveness and institutional responsiveness while considering the number of crimes in an area.

2.3 Data analysis and tools

The data analysis used in this study involved various spatial statistical tests to explore and examine the distribution, clustering, and spatial modelling of crime incidents across different police regional offices in the Philippines. It focuses on four main results: hotspot analysis, spatial autocorrelation, spatial regression modeling, and spatial clustering.

Prior to spatial analysis modeling, all the variables were examined to ensure completeness and consistency. The dataset contained no missing values and continuous variables were standardized to ensure comparability across region. Row standardization was applied to ensure that each region's spatial influence was proportionally weighted relative to its number of neighbors. Diagnostic checks were performed and showed no evidence of multicollinearity among the independent variables.

The monthly crime data from January 2022 to September 2023 were aggregated at the regional level to calculate the crime incidence and solution efficiency. This study paper focuses on the spatial analysis across regions rather than the temporal trends in order to assess spatial clustering and regional disparities.

The hotspot method was performed to identify areas with high concentration of the eight (8) focus crimes of the PNP. This spatial method provides a visual representation of crime density across regions. To examine relationship, spatial autocorrelation using Global Moran's I was utilized to measure the degree to which similar crime values cluster in space. And to further understand the spatial relationships and factors contributing to increased crime incidents, a Spatial Lag Model (SLM) was applied. SLM considers the influence of crime rates in neighboring regions and allowed for a more accurate assessment of the drivers of regional crime in the country. Spatial clustering analysis was conducted using a spatial scan statistic to detect statistically significant clusters of high or low reported crime cases.

A combination of three software programs, QGIS 3.4, GeoDa, and SaTScan, was used to perform hotspot mapping, spatial autocorrelation testing, spatial regression (Moran's I and Spatial Lag Model), and spatial clustering analysis. These tools are free and open-source which enable researchers to conduct advanced exploratory spatial analysis without license restriction. SaTScan focused

on low-risk (cold spot) clusters to identify regions where crime incidence is consistently low and solution efficiency is high. This approach highlights regional variations in crime and law enforcement practices, which may provide useful descriptive insights for policymakers and law enforcement agencies.

3. Results and Discussions

3.1 Crime incidence

Fig. 2 illustrates the trend of eight (8) reported focus crime cases in the Philippines from January 2022 to September 2023. As depicted in the figure, the highest total number of reported cases is theft which was consistently high throughout the period considered. It shows lower number of cases at the beginning and end of the year and fluctuates at a higher level in the middle of 2022 and 2023. This pattern may be due to the increased police presence deployed during holiday season such as Christmas and New Year [23]. In contrast, mid-year periods are often associated with financial pressure and economic hardship, which correlate with an increase in crime incidence [24]. Rape incidents exhibit a spike in July 2023 but follow a relatively lower and stable trend in the following months. As observed also, there is a pattern of low reported robbery cases every May in both 2022 and 2023. This incidence is due to several socio-economic, demographic and environmental factors such as community engagement, and seasonal social routines [25, 26, 27]. While murder and physical injury show a stable number of crime cases. And carjacking of motorcycles (MC), homicide, and carjacking of motor vehicles (MV) shows some variations but no significant peaks or declines, indicating a more stable trend for these types of crimes during the observed timeframe.

The latest report from the national crime statistics shows significant decrease in focus crimes during the first quarter of 2024, with a 21.68% drop from 7,583 cases in the same period in 2023 to 5,939 cases. This decline is due to strengthened law enforcement action

and greater public cooperation which reflects the effectiveness of proactive crime prevention strategies [28].

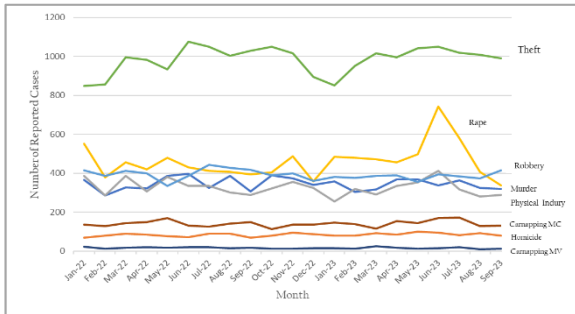


Fig. 2. Trend of Reported Focus Crime Cases (Jan 2022 – Sep 2023).

The distribution of the total number of crimes reported and the number of crimes solved across different areas of the Philippines is presented in Table 2. The outcome of the analysis displayed significant variance among the number of recorded crime incidents under both peace and order and public safety incidents. To clarify, the National Capital Region Police Office (NCRPO) has recorded the most crime incidents in both peace and order incidents and public safety incidents. The next highest Police Regional Office is CALABARZON, with recorded peace and order incidents totaling around 54,349 incidents and recorded public safety incidents totaling 34,964 incidents. The high recorded number of crime cases in the NCR area is reflective of the area having a higher population density [21] and the effectiveness of proactive law enforcement strategies [29].

In terms of reported crimes, the NCRPO has the leading total of 179,719 cases between January 2022 to September 2023, as a result of the size of the NCR population, which might result in reporting of more crimes committed. Next is CALABARZON with 89,313 cases, and Central Visayas with 71,473 cases, which is reasonable due to high population density in those highly urbanized areas. In contrast, the lowest reported regions were PRO COR (6,130), PRO BAR (4,349),

and PRO 4-B (MIMAROPA) with 7,440. These numbers could justify low level of crime or cases could be under reported due to geographic limitations from other factors. Overall, the range of crime adversity from region to region is highlighted by these numbers.

Table 2. Distribution of Crime Cases and Solved Crime Across Philippine Regional Offices.

Police Regional Offices	Crime Incidents			Total Crime Solved
	Peace and Order	Public Safety	Total	
PRO 1 – Ilocos Region	8,460	5,301	13,761	1,1197
PRO 2 – Cagayan Valley	6,987	4,763	11,750	9,664
PRO 3 – Central Luzon	28,562	34,502	63,064	57,012
PRO 4-A - CALABARZON	54,349	34,964	89,313	75,310
PRO 4-B - MIMAROPA	5,008	2,432	7,440	5,612
PRO 5 – Bicol Region	12,862	16,485	29,347	23,027
PRO 6 – Western Visayas	18,251	18,790	37,041	29,586
PRO 7 – Central Visayas	40,118	31,355	71,473	65,368
PRO 8 – Eastern Visayas	8,858	5,557	14,415	11,361
PRO 9 – Zamboanga Peninsula	7,377	4,694	12,071	9,984
PRO 10 – Northern Mindanao	12,507	11,892	24,399	19,566
PRO 11 – Davao Region	40,427	4,675	45,102	43,099
PRO 12 - SOCCSKSARGEN	8,576	7,543	16,119	12,207
PRO 13 – Caraga	7,418	6,515	13,933	10,524
PRO BAR – Bangsamoro Autonomous Region	4,010	339	4,349	2,447
PRO COR – Cordillera Administrative Region	3,085	3,045	6,130	4,755
NCRPO – National Capital Region	65,102	11,4617	179,719	165,136
Total	331,957	307469	639,426	555855

The NCRPO also accounts for the highest number of solved crimes, with 165,136, which corroborates the high number of resolved crimes. CALABARZON had the second highest number of solved crimes with 75,310 cases, and Central Visayas followed closely behind with 65,368, which also reflects where high levels of reported incidents were observed. In the Bangsamoro Autonomous Region (2,447) and Cordillera (4,755) region, low amounts of solved on incident reports were noted, matching lower crime incidence records in reported data. A total of 555,855 of 639,426 of crimes reported were resolved and the national average of approximately 87% resolution efficiency overall across all regions in the country represents a reasonable average when incident reporting rates are high from previous years. This means generally, crime reports and overall cases were settled equitably across the board across all police regions.

In the Philippines, the Department of Justice (DOJ) plays a crucial role in the prosecution and conviction of cases aside from the PNP. In an assessment, the success of the DOJ in prosecuting cases relies on the quality of investigations and evidence gathered by the PNP. This interdependency underscores the necessity of strong coordination and collaboration between these two vital government agencies to ensure effective crime solution.

3.2 Hotspot analysis of major crimes

Fig. 3 displays the hotspot analyses for the eight major crime types across different police regional offices in the Philippines. Each sub-figure (a-h) presents a heat map that indicates the spatial concentration of reported incidents for a specific crime. The color gradient ranges from light to dark red, with darker shades representing higher densities of reported crimes and lighter shades indicating lower densities.

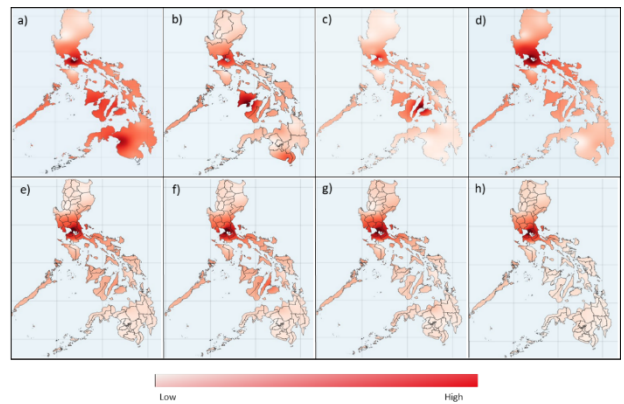


Fig. 3. Hotspot Analysis of Major Crimes in the Philippines: a) Murder; b) Homicide; c) Physical Injury; d) Rape; e) Robbery; f) Theft; g) Carnapping MC; and h) Carnapping MV.

As seen in the map of murder cases, areas with darkest shades are observed in CALABARZON, CABARMM, the Autonomous Region, and the National Capital Region, meaning the highest rates of reported murder in the nation. The high murder rate in BARMM is primarily due to a legacy of armed conflict, the existence of firearms, clan feuds, and the persistence of poverty [30, 31]. The darkest shades may also be seen in Western and Central Visayas, reflecting relatively high murder counts in these regions. In areas of the northern part of Luzon, including the Cordillera Administrative Region, the Ilocos Region, and the Cagayan Valley, lighter shades are seen, referring to fewer murders counted, which may mean fewer murders or more effective local conflict resolution.

As for reported homicide in map (b), the highest areas reported by this case are Western Visayas, NCR, CALABARZON, and SOCCSKSARGEN. The lowest counts reported are located in the Bangsamoro Autonomous Region, Cordillera and, MIMAROPA, indicating a relative fewer number of homicides reported. The higher reported averages of homicide in SOCCSKSARGEN may be related to armed conflict, clan feuds (also known as rido), and violence related to insurgency, especially in South Cotabato and Sultan Kudarat.

Crime data in map (c) show that there are indications of lower levels of physical injury occurrences in the northern and southern regions of the Philippines. The majority of physical injury incidents are spatially located in some parts of the Visayas and the National Capital Region (NCR). For rape incidents in map (d), the darkest areas occur in Luzon, specifically in NCR and CALABARZON. For the crime types of robbery, theft, and carnapping (motorized vehicles and motorcycle), the data show that the NCR, CALABARZON, and Central Luzon, were consistently the three regions with the most cases. It is possible to reason that these areas are highly urbanized, with a denser population compared to other locations in the Philippines, which may explain the higher rate of property crime incidents overall. On the other hand, the low number of crime incident cases for these four crime types consistently found in Mindanao and northern areas of Luzon, may suggest lower crime incident density in less urbanized, more rural areas.

In general, densely urbanized areas tend to produce more social friction and offer greater opportunities for crime, which may lead to higher crime rates [32, 33]. Thus, the need for specific crime prevention policies that are relevant to the particular social, economic and geographical characteristics of a region is critical.

3.3 Spatial analysis of crime incidence and crime solved

The map in Fig. 4 presents the spatial distribution of the total number of reported crime incidents and solved crimes in the Philippines. The legend indicates that darker shades of blue represent areas with a higher incidence of crime, ranging from "Very Low" (lightest blue) to "Very High" (darkest blue). Looking at the map in the left side (a), it can be seen that the very high level of crime is concentrated in some parts of the Luzon including NCR and its surrounding areas like CALABARZON, and Central Luzon, as well as Central Visayas. The Davao region, and

some part of Visayas such as Western Visayas and Bicol Region fall under the high crime category while Northern Mindanao, SOCCSKSARGEN, and Eastern Visayas are classified as having moderate crime levels. Additionally, regions such as Caraga, Zamboanga Peninsula, and the Ilocos Region are classified as having low crime levels, while BARMM, the Cordillera Administrative Region (CAR), Cagayan Valley, and the MIMAROPA Region exhibit very low levels of crime.

The map on the right side (b) illustrates the spatial distribution of solved crime rates across regions in the Philippines. It shows that regions such as Davao Region, NCR, Central Visayas, and Central Luzon are classified as "Very High", implying strong performance by police officers in implementing law enforcement to solve crimes. High levels of solved crimes are also observed in areas like CALABARZON, Zamboanga Peninsula, and Cagayan Valley. Meanwhile, regions such as Northern Mindanao, Ilocos Region, and Western Visayas exhibit only moderate levels of solved crimes. In contrast, regions like Eastern Visayas, Bicol Region, and CAR, fall under category of "Low" and "Very Low" including the regions of SOCCSKSARGEN, MIMAROPA, CARAGA, and BARMM. This suggests potential problems and poor performance in the effectiveness of law enforcement implementation or challenges in resolving criminal cases.

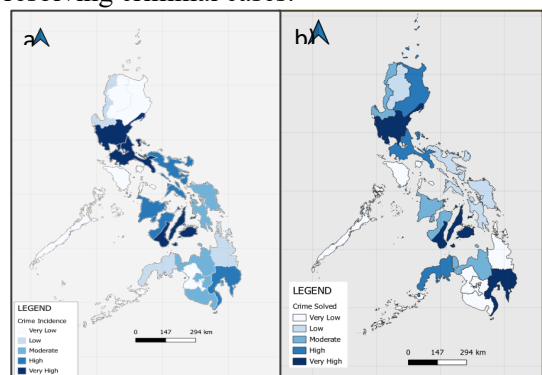


Fig. 4. Spatial Analysis of a) Total Crime Incidents; and b) Solved Crime Rate.

Davao Region has been recognized for its relative success in crime resolution, anti-drug campaigns, and maintaining an insurgency-free status [34]. And according to the study by [22], NCR, Central Visayas, and Central Luzon experienced significant crime reductions due to their aggressive operations, proactive policing, and comprehensive peace strategies.

3.4 Spatial regression

The findings from Table 3 indicated that the Moran's I statistic for the region is 0.384 with a p -value of 0.000. Since the p -value is less than the level of significance of 0.05, we reject the null hypothesis of no spatial autocorrelation and accept that a statistically significant positive spatial autocorrelation exists over the regions. Therefore, the distribution of the variable is not random, but instead demonstrates an identifiable pattern of similarity among neighboring regions. This means patterns with similar characteristics of crime regionally tend to cluster together with moderate spatial association (0.384).

Table 3. Moran's I Statistic.

	Standard Deviate	P-value	Decision
Region	0.384	0.000	Value > 0

Further analysis was conducted using a Spatial Lag Model to look into the factors that influence the crime rates taking place within the regions (Table 4). The number of police stations was negatively and statistically significantly associated with crime rates (coefficient = -511.28, $p < 0.01$), indicating that regions with more police stations tend to report lower crime rates. Unemployment showed a positive and statistically significant association with crime rates (coefficient = 20,273, $p < 0.05$), suggesting that regions with higher unemployment tend to have higher crime rates. Similarly, population was positively and statistically significantly associated with crime rates (coefficient = 0.0063, $p < 0.01$), indicating that regions with

larger populations tend to have higher crime rates.

Table 4. Spatial Lag Model (SLM).

Variable	Coefficient	P-value
Constant	46540.32	0.604
Police Station	-511.28	0.000**
Inflation	-4908.32	0.081
Educational Attainment	1987.41	0.413
Unemployment	20273	0.024*
Population	0.0063	0.011**
Poverty	-570.65	0.467
Lag coefficient (ρ)	-0.144	
R-squared	0.887	
AIC	138.12	
BIC	144.79	

* significant at 0.05, ** significant at 0.01

The estimated spatial lag coefficient ($\rho = -0.144$) suggests a weak inverse spatial effect in crime rates across regions. The negative coefficient may reflect spatial heterogeneity, aggregation effects, or model specification given the small number of spatial units. This indicates that the constructed model is a good model fit with an r-squared value of 0.887 with AIC and BIC of 138.12 and 144.79, respectively, which means that the model explains 88.7% of the variation in the regional crime rates across the studied areas.

The factors of unemployment and poverty studied by [35] have an expectedly positive impact on crime rate increases. The global study by [36] showed that a 10% increase in police station density was correlated with a 3% decrease in property and violent crime rates which further supports the idea that more police infrastructure will contribute to reducing crime. Similarly, [37] showed that higher unemployment rates increase economic pressure which consequently pushes more persons toward criminal behaviors. [38] used the World Bank and crime data from the Philippines (1990–2018) to estimate the effect of population on

crime rates. Their regression output showed a statistically significant positive coefficient (2.18, $p < 0.001$) indicating regions with larger populations consistently experience higher overall crime rates. They concluded that the phenomenon is a result of increased urban density and more social interactions.

3.5 Spatial clustering

Fig. 5 below shows the visual presentation of spatial clustering of reported crime cases in the Philippines, specifically highlighting areas with statistically significant clustering of low crime rate using Moran's I spatial autocorrelation. The blue shaded circles represent the spot where incidence of crime is significantly lower than what would be expected by random distribution across the region.

Table 5 presents the results of a spatial cluster analysis identifying significant areas with lower-than-expected case counts, indicating low-risk or "cold spot" clusters. The analysis created three clusters: Cluster 1 in northern Philippines, Cluster 2 in the central-east Philippines, and Cluster 3 in the south-west Philippines.

In Cluster 1, there were 31,641 reported cases and the total number of expected observations based on a random distribution was significantly higher at 63,453. This indicates a ratio of observed/expected of 0.50 and a relative risk of 0.47, meaning individuals in that area were about 53% less likely to experience the crime than those out of the cluster. The observations represent a highly statistically significant log likelihood ratio of 10657.69 reaching a p -value = 0.001, which confirms that this under-representation of cases is statistically significant.

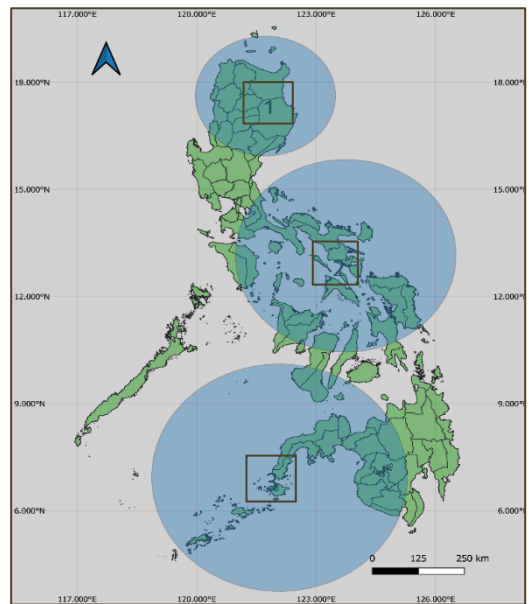


Fig. 5. Spatial Clusters of Crime Incidence in the Philippines.

Similarly, Cluster 2 experienced 88,243 reported cases which is also lower than the expected 128,339. The observed/expected ratio of 0.69 and relative risk of 0.64 suggest that the risk of crime in this cluster is approximately 36% lower. The statistically significant log likelihood ratio of 8575.23 with a p -value of 0.001 indicates the lower-than-expected number of cases is statistically significant, allowing us to be confident in our estimate of a 36% lower risk of crime in this second cluster.

Lastly, Cluster 3 had 56,938 cases which again is considerably less than the expected number of 105,012. Thus, the observed/expected ratio of 0.54 and relative risk of 0.50 indicate that the risk of crime within this cluster is approximately half of what would be anticipated. The highly significant log likelihood ratio (15321.92) with p -value of 0.001 confirms that the observed crime cases are statistically significant.

Table 5. Significant Spatial Clusters of Cases Based on Observed and Expected Counts.

Cluster	Number of Cases	Expected Cases	Observed/Expected	Relative Risk	Log Likelihood Ratio	Risk Reduction	P-value
1	3164	6345	0.50	0.47	10657	53%	0.001
2	8824	1283	0.69	0.64	8575	36%	0.001
3	5693	1050	0.54	0.50	15321	50%	0.001

4. Conclusion

The study employed spatial analytical approaches to investigate crime incidence and solve rates, as well as socio-economic determinants across seventeen (17) police regional offices in the Philippines, based on data collected from January 2022 to September 2023. Findings revealed that spatial clustering of reported crimes is high in highly urbanized areas such as NCR, CALABARZON, and Central Visayas. Spatial regression identified unemployment, population, and the number of police stations as significant factors influencing reported crime cases. Spatial clustering emphasized regions with low-risk cases with significantly fewer crime cases than expected. Overall, findings highlight the importance of crime variation across regions to inform evidence-based policing and policy interventions.

The recommendations from the study include encouraging policymakers to prioritize resources for the highly urbanized regions where crime is concentrated, stressing the importance of advocating for community policing that encourages greater police interaction with communities in policies, and to provide education and employment opportunities for longer-term prevention measures. Also, future research should explore localized crime drivers at the city or municipal level and assess the effectiveness of current policing strategies using time-series and panel data approaches.

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