

Exploratory Time Series Analysis of Violent Crime in Malaysia

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ABSTRACT

This study investigates the dynamics of violent crime rates in Malaysia between January 2014 and April 2024 through specific Exploratory Data Analysis (EDA) such as Descriptive Statistics and Time Series Visualization. The findings reveal a complex and heterogeneous crime landscape. Robbery constitutes the most frequent and seasonally sensitive offence, exhibiting pronounced variability across the study period. Assault, while relatively stable, reflects fluctuations aligned with broader social interactions. Rape demonstrates a gradual upward trajectory, with notable surges during holiday periods, likely linked to evolving reporting practices and heightened social awareness. Murder remains episodic and unpredictable due to its low base frequency. Overall, the analysis underscores the multifaceted nature of crime in Malaysia, highlighting the interplay of temporal, social, and contextual factors that shape crime patterns. These descriptive insights provide a clearer empirical overview of crime trends and can be used as an initial foundation to further research.

Keywords: Exploratory Data Analysis, Time Series Analysis, Crime Statistics

1 INTRODUCTION

Though the overall level of crime in Malaysia has been falling over the past few years, violent crime types like murder, rape, robbery, and assault are issues of concern, especially in the urban areas [1]. The paper is therefore an endeavor to identify the trends in the crime rates in Malaysia, aided by Exploratory Data Analysis (EDA). It utilizes the secondary data on the cases of violent crimes reported in Malaysia, which has been extracted from the Royal Malaysia Police Department. The information is based on monthly crime data between January 2013 and April 2024, and each type of crime data has 136 data points; therefore, the 4 categories of robbery, assault, rape, and murder have 544 data points. The highlighted data represent the critical attributes of the trends of violent crimes in Malaysia, which suggest the general overview of the temporal trends of crimes. The data is presented on a monthly granularity level, which gives in-depth analysis of the changes in trends in crime over time, as well as whether crime shows changes by the seasons and by structures. Upon utilization of different reports of types of crimes or geographical grounds lies a broad perspective of the dynamics of crimes in Malaysia.

Sweden has seen a sharp increase in violent crime, especially gang-related shootings and bombings, which makes it the European country with the highest death rate as of 2022. According to the Swedish Crime Prevention Council (Brå), more than 60 deaths related to weapons and more than 60 bombings were reported in 2023, with major cities such as Stockholm and Malmö affected [2]. These crimes are largely affected by increasing arguments between organized criminal networks, many of whom are involved in the second generation of immigrants. The violence has led to national concern, especially after prominent incidents such as the bombing in September 2023 in Uppsala, which killed a 25-year-old woman unrelated to the incident [3]. In response, Swedish authorities have expanded police powers, proposed severe laws on deportation for individuals associated with gangs, and intensified cooperation at the EU level. However, these measures have started debating civil liberties, immigration policy, and social integration in response to this, which reflects Sweden's complex socio-political consequences of the evolution of crime.

A state of emergency was enacted through a massive anti-gang push, initiated in March 2022, and has consequently resulted in an absurd 98 percent drop in the murder rate in El Salvador since the year 2015 alone, as the country entered the year 2024 with more than 106 murders per every hundred thousand of the population only then, and the current rate stands at 1.9 per every hundred thousand [4]. In such a regime, over 83,000 people who were suspected of gang membership had been detained, and the public had been granted fewer rights so that the security forces could exercise their powers. In 2024, murders in the country were at a record low of 114, and a survey showed that 88 percent of the people in El Salvador reported that they felt safe walking alone during the night, and this was a big change in attitude. This security breed, however, has been faced by a tremendous counteraction amongst individual human rights groups due to claims of arbitrary arrests and imprisonment, crowded prisons, and an alarming statistic of deaths in prisons that, according to the records, stands at 354 [5].

Before the formation of some predictive models, Exploratory Data Analysis (EDA) is very significant in gathering information about the data. Depending on descriptive statistics, several other relevant statistics shall be used, including the mean, the variance, skewness, and kurtosis, to present the study on the median point and spread of crimes in the various states and types of crimes [6]. It will enable one to acquire an opportunity to discover the probable outliers and irregularities in the data. In addition, time series analysis and graphical methods of time series, such as visual analysis, line plots, seasonal decomposition plots, and correlograms, will also be used to explore the purpose of time series to indicate trends (up or down trend), seasonality, and periodicity. These graphical representations can make a significant contribution to an understanding of the dynamics of crime rate, and they can aid in identifying the structural breaks or anomalies that could be disturbing the selection of the model [7]. Overall, exploratory data analysis (EDA) is an important initial step for choosing a suitable forecasting method, which helps to identify the important features of the data set. In order to come up with credible and understandable predictions of the violent crime rates in Malaysia, it is necessary that the background trends and patterns are studied carefully so that the model employed captures the nature of crime occurrences.

2 EXPLORATORY DATA ANALYSIS (EDA)

Exploratory Data Analysis (EDA) is a broad framework of both statistics and data science that is used as a form of data science and data statistics to summarize, visualize, and interpret the structure of data with the aim of better grasping it in order to model it using more systematic forms of data modeling. It helps determine patterns, trends, anomalies, and potential relationships existing in the data sets [8]. The possibility of visualizing time series, as well as descriptive statistics, could be narrowed down and be categorized as EDA because it will provide a user with alternatives where the data can be understood instead. Descriptive statistics can offer numerical summaries based on measuring the central tendencies and variability, whereas the visualization techniques of time series, such as plots of lines and seasonal decomposition, could be applied to depict the ideas of underlying structure, e.g., trend and/or seasonality [9]. With EDA, the quality of data can also be explored by researchers to determine whether the data contains some missing or extreme values and what transformation or preprocessing actions are best to do prior to modeling. This will ensure that the type of method to be used in forecasting is in line with the characteristics of the data and that it improves accuracy and interpretation of predictive models.

2.1 Descriptive Statistics

Table 1: Descriptive statistics of four different types of crime

Variable	Mean	Standard Deviation	Minimum	Maximum
Murder	30.74	11.90	8.00	66.0
Rape	158.71	33.70	71.00	258.0
Robbery (Gang + Individual)	908.2	438.0	197.0	2005.0
Assault Causing Injury	396.64	68.58	233.0	556.0

The average monthly number of murders in Malaysia between January 2013 to April 2024 is 30.74 with the relatively low dispersion rate between 8 and 66 cases. This implies that even though the cases of murders have been encountering both low and high rates, the cases fall at a manageable level compared to other types of crimes. The average of rape cases however was very high with 158.71 cases per month as compared to the range of the cases observed which was 71 to 258 cases and this could be attributed to the seasonal factors or the situational factors as there are huge differences in small quantities of rape cases. The various four categorizations of the crimes have provided an indication that the prevalent of the crimes is the robbery category which has an average of 908.20 a month and highly unstable as depicted by the extremes of 197 and 2005. This kind of volatility keeps returning on receptivity of the rate of robbery to a sudden variation, which may or may not be linked

to social-economic (or opportunistic) aspects. The regular patterns in regard to robbery are assault leading to injury that includes gang assault and individual assault and averages at 396.64 cases per month with a record between 233 to 556 cases per month is classified as moderately high but more stable comparatively to robbery. This homogeneous information signals the lack of crime homogeneity across the Malaysian context that will have to be viewed as such in the subsequent phases of trend and pattern study.

2.2 Time Series Plot

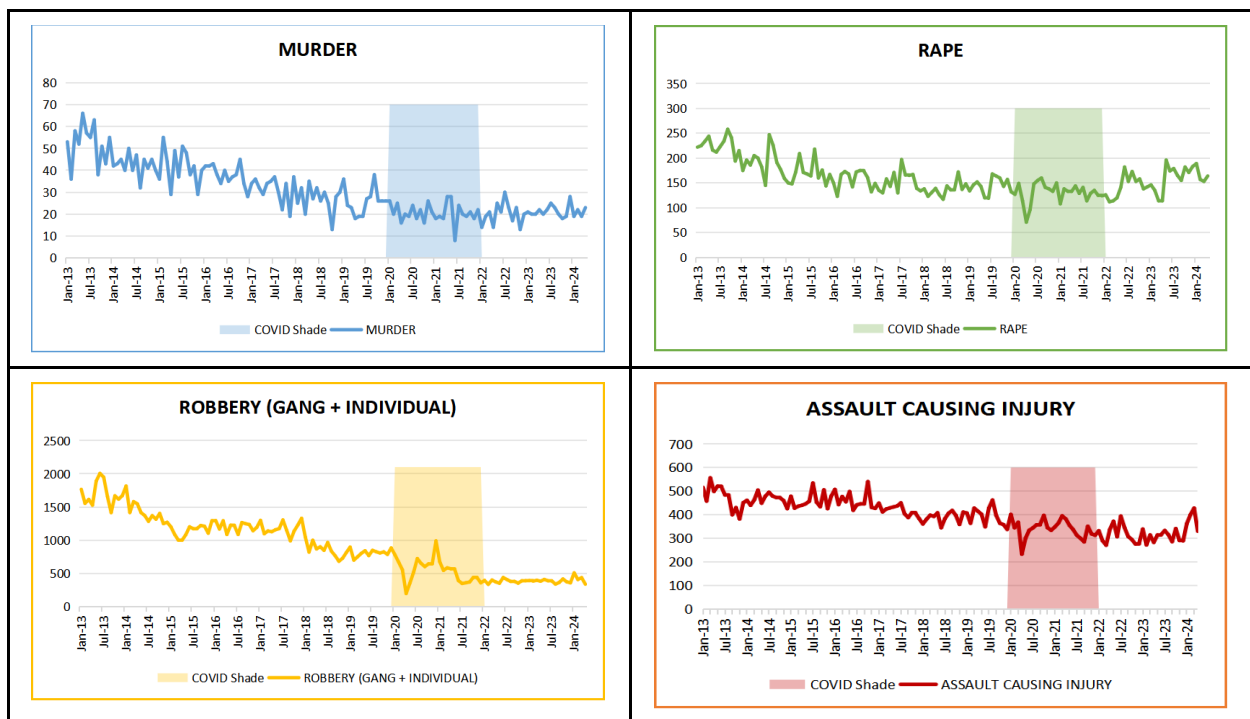


Figure 1: Individual Time Series Plots of Monthly Reported Murder, Rape, Robbery, and Assault Cases in Malaysia, January 2013 – April 2024

Murder has the lowest seasonality because of the low magnitudes and volatility. They show occasional surges in December-January and June-July, although these are not regular and are probably the result of situational: events not a regular seasonal cycle. The murder rates also declined to below historical levels during the COVID-19 period (2020-2021) in line with decreased public mobility and limited opportunity structures. Once 2022 is over, this situation looks more random in the month-to-month dynamics, which supports the hypothesis of the stochastic characteristic of low-frequency offenses.

Rape offenses have a constant estimate having slight seasonal variations. When it comes to increase, peak months are usually during the months of the holidays at school (June and December), which may be attributed to a change in supervision patterns. Possible declines are registered in the months of February and in Ramadan a floating month (May to July in other years), where family absence and change in routines can be a deterrent factor. Exceptionally, rape patterns significantly decreased during 2020-2021 because fewer crimes were committed on the one hand due to the limitations imposed on mobility and on the other hand because illegal activities were not reported on grievance. It is clear that there is a rebound in 2022 associated with the lifting of restrictions and the activity of the population in society.

Assaults have seasonal patterns, but the variation is moderate, e.g. peaks in June-July (school holidays, mass gatherings) and in November-December (festive season, social functions), corresponding to times of increased interpersonal contact. The drop-offs can be seen in February-March when cultural holidays or low nightlife becomes a factor. The cases of assaults perceptibly diminished during the pandemic (2020-2021), especially at the time when tight Movement Control Orders (MCOs) were imposed and socialising in society was restricted. There is however a reversion to the previous seasonal cycle after 2022 onwards, however the height of the peaks does not seem to be as pronounced which implies a potential shift in behavior or echoing effects of policing.

The most pronounced seasonality is the case of robberies, where there is a stable tendency of reaching the maximum value in November-December in the majority of the series years (2013-2019, and again in 2022-2023). This coincides with end of year bonuses payments, holiday shopping, and higher rate of mobility in cities, which makes stealing a very easy option. There is a secondary peak in May-June (school holidays and mid-year sales), which is also associated with increased activity of society. Visible through-puts are seen in February, especially in the years where the Lunar New Year occurs as shorter working weeks and family gatherings limit availability of targets. Nevertheless, the pattern was demolished during COVID-19 lockdowns (March 2020-mid-2021) when the number of robberies decreased significantly irrespective of the season. The typical holiday spikes assailed by the restrictions in mobility, business shutdowns and heavy police presence were bypassed. The seasonal pattern slowly returned in late 2021-2022 after restrictions were lifted, but with slightly weaker than pre-pandemic peaks.

3 DISCUSSIONS

The exploration approach enabled the investigation of crime data in Malaysia, between January 2013 and April 2024, in the quest to reveal the multidimensional temporal changes in four major categories of crimes. Robbery, more than others, is the prevailing terrain, not only in gross numbers but also in fluctuation, in the monthly totals with the dive down to lower hundreds and the ascent to better than two thousand. This volatility will most probably be charged due to the minimal dynamics of altering social-economic factors and exposure to the opportunity structures since it correlates to the yielding of the long-term relations between the economy and the crime as exhibited in the Autoregressive Distributed Lag (ARDL) Malaysian analysis, a time-series econometric model that captures both short-run dynamics and long-run equilibrium relationships between variables by

incorporating lagged values of the dependent and independent variables, where the economy dynamic accompanies the crime dynamic [10].

Violence is more than akin but more stable and permanent, and this fact demonstrates its character of a socially endemic problem that is less exposed to external shocks in the short time perspective. Murder, on the contrary, has been stuck on the lower side with some moments of increasing but in comparison to rape that seems to have points on an upward moving trend perhaps owing to increased societal awareness in reporting the cases of rape and its execution being done more effectively than the Department of Statistics Malaysia where there was an 11.8 increase in 2023 compared to 2022 in the measurement of rape [11].

More insight can be obtained by looking at time series plots: robbery and assault show strong seasonality with spikes in November-December and June-July, when the general population is more active around end-of-year holidays and school holidays. Such observations resonate with the routine activity approach to the explanation of a social congregation and economic exchange as contributors to an opportunistic crime. In the meantime, rape and murder have weaker and more subtle seasonal patterns signifying that their causes tend to be structural, situational, or episodic as opposed to cyclical.

Year 2020-2021 is an undoubtedly structural break including the Movement Control Order (MCO) in Malaysia and the larger COVID-19 lockdowns. Crime indices even with an increasing unemployment rate plunged drastically and in line with the results of a national study reporting lesser crime index during MCO owing to lack of mobility and increased guardianship [12]. This is mirrored at the urban-level evidence in Kuching, Sarawak, where the number of property crimes alone fell to 1,144 cases in 2020, 813 cases the following year (2021) and 683 cases briefly in 2022 [13].

The patterns serve to highlight the fact that Malaysian dynamics of crime are found in the interplay of long-term structural patterns, seasonality bloodshed cycles, and sudden external shocks. These factors should be incorporated well into the forecasting frameworks so that sturdy and dynamic forecasts are created.

4 CONCLUSIONS

Initial analysis of crime statistics in Malaysia during the 12-year interval in the year 2013-2024 offers a multidimensional picture that criminals have engaged in robbery as the most varied and seasonal crime in comparison to assault which is very stable and by reacting to social developments [14]. Rape is one that displays a consistent upward trend which even though the increase during holidays occurs, shows a conspiracy of changes in feedback and social awareness. A result of murder being a low base rate phenomenon is that it is random and episodic in nature.

The COVID-19 lockdowns (2020-2021) marked the beginning of a significant change in all types of crimes proving the routine activity theory because the classic crime opportunity was blocked as never before as citizens were literally confined to the ground [15]. In a post-pandemic arena, crime patterns have partially recovered, yet at a diminished seasonality, which signifies ongoing changes in behavior or policy at enforcement.

The exploratory data analysis (EDA) performed in the research indicates that the crime patterns in Malaysia might have a structural variation or seasonal effects such as a potential holiday-related variation, irregular shocks based on unexpected events. These observations are still however, suggestive and not conclusive because there are no formal statistical procedures that would confirm the existence of structural change. However, the trends determined with the help of EDA give a significant initial insight into the time dynamics of the data. These experiences are useful in informing future analytical efforts, especially in informing the aspect of trend, seasonal and potential intervention elements of more formal modelling structures. Therefore, the EDA is a necessary preliminary step, which provides contextual clarity that aids the design of more intensive and empirically based studies in the future research.

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