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Preface

This e-book describes the research papers presented at the International Conference on Emerging Computational Technologies (ICECoT 2021), organised by Faculty of Computer and Mathematical Sciences (FSKM), UiTM Cawangan Melaka. The main discussions of the conference is on the technological advances that help shape the skills that are required to cope with the Fourth Industrial Revolution (IR 4.0). Considering that this is our first attempt at organising a conference, we are therefore greatly honoured that the Universitas Negeri Semarang (UNNES), Indonesia, Mahasarakham University (MSU), Thailand and University of Hail (UoH), Saudi Arabia have all agreed to become our partners by contributing several reseach papers as well as providing reviewers to assess the quality of the papers.

Out of the numerous research works that had been submitted and reviewed, the Editorial Board have selected 22 papers to be published in the e-book. The discussions of these papers pertain to the use of technologies within the broad spectrum of Computer Science, Computer Networking, Multimedia, Information Systems Engineering, Mathematical Sciences and Educational Technology. It is hoped that the research findings that are shared in this e-book can benefit those who are interested in the various areas of computational technologies; such as graduate students, researchers, academicians and the industrial players, to name a few.

As the Project Manager, I would like to thank all of the committee members from the bottom of my heart for their tireless efforts in ensuring the success of ICECoT 2021. Without their continual support and excellent teamwork, this conference would not have come to fruition. In fact, holding this major event has been a good learning experience for us all, and I sincerely believe that our future conferences will become more outstanding if the same spirit is maintained.

Dr. Noor Aishikin Adam

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Data Visualization of Violent Crime Analysis using Plotting Map Technique

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Abstract— Crime can be concluded as an illegal act punishable by a state that can affect social, economic, health effects on someone and can reduce the quality of life of individuals or the community. Hence, Royale Malaysia Police (RMP) need to enforce laws to control the crime. In addition, some of the community established a society to eradicate the crime. However, there are some barriers in the community and Royale Malaysia Police such as the community has limits crime information and a lack of good quality of crime information. In addition, RMP has its own difficulty when it comes to investigating a crime, and they depend on the community's cooperation. As a solution, a data visualization of violent crime analysis model using plotting map technique that used New York's violent crime dataset has been developed to help the community and RMP to combat the crime. This model allows users to determine the trend, frequency, percentage, and locations violent crime occurred. This model follows the Cross Industry Standard Process methodology. The usability test has been conducted for the purpose of the ability to use by the user which are 26 out of 51 respondents highly agreed this model able to use by the user. The significance of this project is to help the community and RMP to combat the crime and reduce violent crime indirectly. In future, this model can be used to predict and determine the location of the next crime in the future.

Keywords—analysis, crime, data analytic, violent crime, visualization

I. INTRODUCTION

Crime causes social, economic, health, and psychological effects on victims and society at large. It directly reduces the quality of life of individuals and the community, it is a serious issue in social problem [1]. According to the researcher, crime is one of a critical issue that has gained noteworthy attention from all countries around the world including Malaysia [2]. Department of Statistics Malaysia has shown 16,902 violent crime cases consists of 323 murder cases, 1,648 rape cases, 10,271 robbery cases and 4,660 causing injured cases were reported in 2018. The government of Malaysia has many efforts to preventing this crime such as more systematic training and advanced specialized courses to improve the capabilities of the police and the Armed Forces as stated in The Star newspaper in 2018.

However, police or The Royale Malaysia Police (RMP) or Polis Diraja Malaysia (PDRM) required the contribution of a community since effectiveness in solving the crime has been reduced. Thus, this effort parallel with the contribution of the community as known as 'Community-Oriented Policing' (COP). COP is a concept whereby the police are the public and the public is the police [3]. But, the community

also required the RMP to provide good quality crime information.

Therefore, this project developed data visualization of violent crime in Malaysia to solve both problems. In spite of that, this project used New York's violent crime dataset to build a model and retrieve information in parallel with Malaysia. Violent crimes such as robbery and causing injured cases are the focus on in this project. Also, statistical analysis and plotting map techniques are implemented to give benefits to RMP and community members.

Existence the Royale Malaysia Police is an alternative to prevent crime in Malaysia. This effort parallel with community contributions or known as "Community-Oriented Policing" which is the best way to creating a safe and secure environment for all. However, community-oriented policing has a limitation which is lacking information, explanation, education and understanding of the crime provided by RMP. In fact, some of the police are still unwilling to share crime information with the community due to the trust issue between police and community, also lack of good quality crime information provided to communities. Besides, the Royale Malaysia Police has sometimes limited its effectiveness in investigating the crime and slow to solve the crime and need contribution from community.

Thus, visualize data of violent crime cases to analyse and identify the trend and the pattern may solve this main problem. By having the project, the Royale Malaysia Police can identify and focus on violent crime in certain areas to prevent crime occurred and reduced crime cases. Hence, the community also easier to identify crime cases that occurred in a certain area and be able to see the same information as the Royale Malaysia Police.

II. LITERATURE REVIEW

A. Crime

According to researchers, crime causes social, economic, health, and psychological effects on victims and society at large, it is a serious social problem that directly reduces the quality of life of individuals and the community. Crime can be defined as intentional commission of an act generally considered socially harmful or dangerous and clearly specified, prohibited and will be punishable under criminal law. According to this book also, Law enforcement professionals often group crimes into the following two categories, violent crimes or person crimes and property crimes as shown in Fig. 1.

Violent Crimes	Property Crimes
Murder and manslaughter	Theft (including shoplifting, embezzlement, Internet fraud, identity theft, and car theft)
Assault and battery (including domestic abuse, child abuse, and vehicular assault)	Burglary
Sexual crimes (rape, sodomy, and child molestation)	Arson
Robbery	

Fig. 1. Category of crimes

Malaysia is one of the countries who had faced this issue. Hence, the newspaper online article stated on 19 October 2018 that the government of Malaysia aims to improve public safety and security as reported. The government effort included improving the capabilities of the police and the Armed Forces through more systematic training and advanced specialized courses. Furthermore, community engagement and participation will significantly reduce crime in Malaysia [4].

B. Violent Crime

The Malaysian Police Reporting System (PRS), which records and stores public police reports and has been strictly controlled by RMP, can be used to obtain information on violent crime [5]. Each reported case is classified either violent and property crimes by an investigating officer and the PRS are available at district police stations, their contingent police headquarters (state level) and the RMP headquarters in Bukit Aman, Kuala Lumpur [6]. Subsequently, Violent crime included murder, rape robbery and assault in Malaysia occurred in fluctuating patterns [7]. For example, Fig. 2 shows 21,366 violent crime and 77,802 of property crime reported in 2017 by the Department of Statistic Malaysia. The violent crime is divided into murder, rape, robbery and causing injury in 2018 is shown in Fig. 3.

According to the literature review in 2016, data visualization of crime in Malaysia already exists, known as “Data Visualization of violent crime hotspot in Malaysia”. This system used GIS and crime mapping technique and implement together to create a powerful tool for crime preventing. However, this review stated that this system does not identify and visualize specific location has high crime rates.

Thus, this study has the same concept from the existing violent crime visualization system but used different technique visualization which is plotting the map, in this context it can be called a crime plotting map. This visualization technique located a more specific location of violent crime.

C. Data Analytics

Big data refer to the dataset which either large or so complex data that traditional data processing application is inefficient [8], big data also appear in multiple sources alarming velocity, volume, variety, veracity. According to the article, data analytic is analyzing raw data with an aim conclusion about the information [9]. There are four types of data analytic descriptive, predictive, diagnostic and prescription.



Fig. 2. Crime index by category 2015-2017

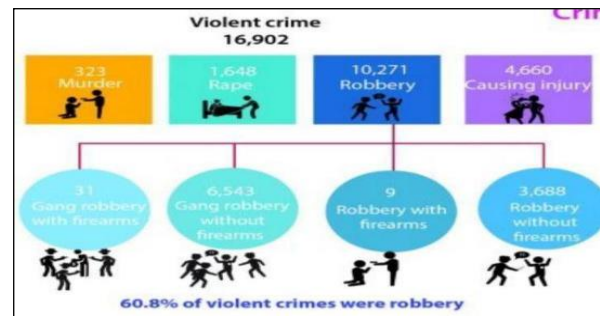


Fig. 3. Number of violent crime case in 2018

Table I shows the summary comparison four types of data analytic with its difficulty and objective of analytic.

TABLE I. COMPARISON OF DATA ANALYTIC TYPE

Descriptive Analytics	Diagnostic Analytics	Predictive Analytics	Prescriptive Analytics
Low complexity	Moderate complexity	High complexity	Very high complexity
Summarize and describe the data	Find the cause in descriptive analytics	Make a prediction from pervious data	Combination of all analytics

D. Data Visualization

Data visualization presented in visual form, information is often much easier to digest, particularly when using patterns and structures that can be intuitively by humans. Visualization of information literacy as the ability to make sense and understand patterns, trends, and connections in data visual representations. Fig. 4 shows an example of each type of data visualization.

Geospatial is the related collective information technology that has a component of geographic or locational [10]. Geospatial that used to indicate information that has geographic component is referred data that have locational information such as geographic data in the form of coordinates, address or city [11]. Geospatial data can be located by GPS data, satellite imagery and geotagging. Geospatial data is a type of Geographic Information System (GIS).

Flow map, a heat map and plotting map are examples of geospatial data visualization. Table II shows the comparison of flow map, a heat map and bubble map. GIS to forecasting crime trends, hotspots and gathering spatial data for several functions [12]. In addition, the article stated that GIS provides law enforcement agencies with a more comprehensive and up to date look at crime trends in their jurisdictions. Malaysia one of the countries used this system. The Malaysian

government has invested this system to map the crime in high prospect zones.

Examples of temporal data visualization include:

- Scatter plots
- Polar area diagrams
- Time series sequences
- Timelines
- Line graphs

Examples of hierarchical data visualizations include:

- Tree diagrams
- Ring charts
- Sunburst diagrams

Examples of geospatial data visualizations include:

- Flow map
- Density map
- Cartogram
- Heat map

Examples of network data visualizations include:

- Matrix charts
- Node-link diagrams
- Word clouds
- Alluvial diagrams

Fig. 4. Example of each type of data visualization

TABLE II. COMPARISON OF DATA ANALYTIC TYPE

Flow Map	Heat Map	Plotting Map
Visualize data flow from the origin-destination	Show the weight of each point in geographical range	Plotted the location by longitude and latitude
Usually used for airlines destination	Usually used for weather prediction	Usually used for analysis information

1) *Plotting Map*: In mathematic definition, a plotting is can conclude as a graphical technique for representing a relationship between x and y coordinates. Plotting also useful for humans to detect the target or object such as using a plot processing on a radar [13]. In this study, the plotting map is being used to plot the location points at the map by using the longitude and latitude of the location as shown in Fig. 5. This technique is useful since this technique can be understandable also can see the main location [14].

2) *Crime Mapping*: Mapping is a technique as shown in Fig. 6, which is mostly used for spatial analysis. Also mapping enriching data with capabilities analyses data in new ways, understand opportunities and risks, and visually interact with the information for more informed decision making.



Fig. 5. Example of plotting map

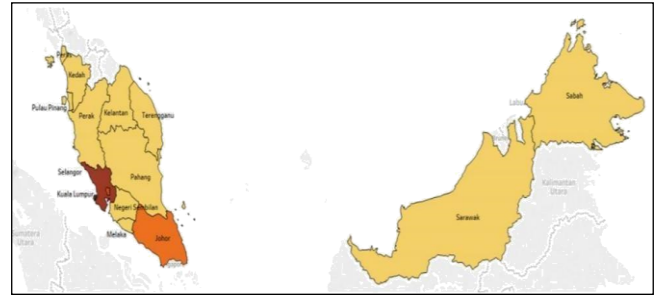


Fig. 6. Example of Crime Mapping

III. METHODOLOGY

There are four current methodologies for crime data mining, Cross-Industry Standard Process for Data mining (CRISP-DM) will be used in this study [15]. CRISP-DM methodology will be chosen in this project because this methodology easily implements and appropriate to this study since there less costly, more repeatable and faster. CRISP-DM consists of six phases there are business understanding, data understanding, data preparation, modeling, validation/evaluation and deployment/ visualization as shown in Fig. 7.

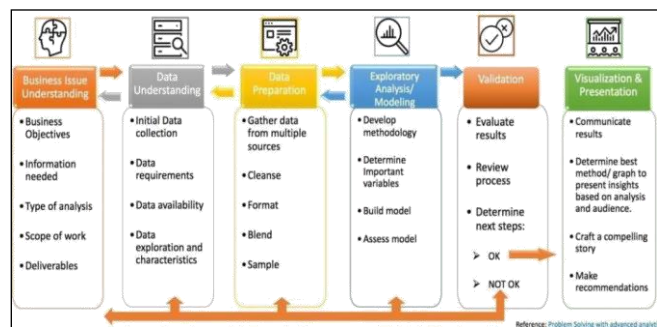


Fig. 7. Cross-industry standard process for data mining (CRISP-DM)

IV. DESIGN AND DEVELOPMENT

A. Data Preparation

1) Data Collection:

This model was use data of violent crime in New York City (NYC) due to some barriers to obtaining data of violent crime in Malaysia, but use the general and commons cases features as in Malaysia such as gender, date of crime and location of the crime occurred. NYC's data on violent crime has about 167 966 records from various types of violent crime and has 18 features such as arrest key, arrest date and law category but this model only select six related features to the

Malaysia data. These data are in the period from 1/1/2019 to 30/9/2019.

2) Data Cleaning:

To ensure that there is no missing data and make data consistent to processed, the cleaning of the data must be done well. this model obtains approximately 18 470 records of violent crimes after removing unnecessari records and six features selected according to the scope of this model and similar features in Malaysia as shown in Fig. 8.

ARREST_DATE	OFNS_DESC	ARREST_BORD	AGE_GROUP	PERP_SEX	PERP_RACE	Latitude	Longitude
09/30/2019	ROBBERY	K	18-24	M	BLACK	40.59968295	-73.93884147
09/30/2019	FELONY ASSAULT	Q	25-44	M	WHITE	40.70451983	-73.8934704
09/30/2019	ROBBERY	K	25-44	M	BLACK	40.67690235	-73.90004715
09/30/2019	ROBBERY	Q	18-24	M	BLACK	40.68004873	-73.77590919
09/30/2019	ROBBERY	B	<18	M	BLACK HISPANIC	40.82859008	-73.87917218
09/29/2019	FELONY ASSAULT	M	<18	M	BLACK	40.82840985	-73.94529438
09/29/2019	FELONY ASSAULT	B	25-44	M	BLACK	40.85580274	-73.84390995
09/29/2019	FELONY ASSAULT	Q	45-64	M	WHITE	40.76177653	-73.73798389
09/29/2019	ROBBERY	M	18-24	M	BLACK	40.73917605	-73.97997026
09/29/2019	FELONY ASSAULT	K	25-44	M	BLACK HISPANIC	40.70629037	-73.95035033
09/29/2019	ROBBERY	M	25-44	F	BLACK	40.80009791	-73.95109665
09/29/2019	FELONY ASSAULT	K	18-24	M	WHITE HISPANIC	40.60384569	-73.96161562
09/29/2019	FELONY ASSAULT	B	25-44	M	BLACK	40.81770983	-73.92397301
09/29/2019	FELONY ASSAULT	M	25-44	M	BLACK	40.7878746	-73.92818165
09/29/2019	ROBBERY	Q	25-44	M	BLACK	40.72279798	-73.85195636
09/29/2019	ROBBERY	Q	25-44	M	BLACK HISPANIC	40.70755934	-73.90403366
09/29/2019	FELONY ASSAULT	Q	25-44	M	WHITE HISPANIC	40.75379382	-73.89357207

Fig. 8. Example of New York City’s violent crime data after data cleaning

B. Data Analysis

Descriptive statistic or descriptive analysis been used in this model to summarize the data and find patterns. Since there is non-numerical data this model analyses the data to find the percentage and frequency by the features. This data analysis is represented by a bar chart for a frequency that allows the user to determine the trend as shown in Fig. 9. Pie chart that allows the user to identify the percentage.

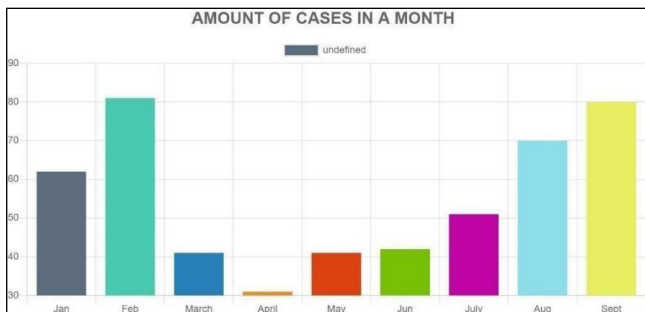


Fig. 9. Violent crime cases reported by month in bar chart

C. Data Visualization

This model displays a map of the visual elements. Hence, by using the longitude and latitude of the data, this model plotted a specific location of violent crime occurred on the map to see and understand the pattern of the data. Fig. 10 shows plotting map of robbery and felony assault in NYC.



Fig. 10. Example of New York City’s violent crime data after data cleaning

D. Visualization Violent Crime Analysis Model

The representation of Visualization Violent Crime analysis model is one that include data analysis and visualization. With using plotting map instead of crime mapping, this model will show the more specific violent crime occur. Also, the users easily identify the location most violent crime occur.

Analysis page was display one drop-down menu that allows users to determine the features to analyses and two buttons which are bar chart button and pie chart button, this allows user to choose the type of visualize. The dropdown menu consists of violent crime cases features such as gender, age, race, district and month, the bar chart buttons was display bar chart to determine the most, the least and the pattern, while pie chart button was display the percentage when users hover over every color as shown in Fig. 11.

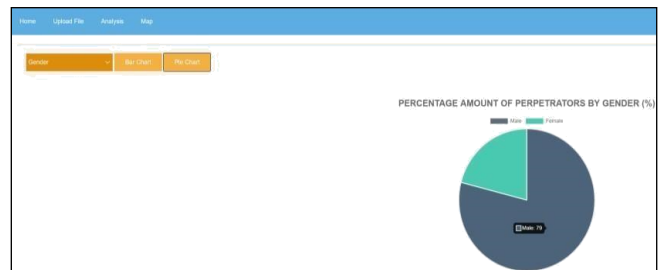


Fig. 11. Example output for pie char and bar chart buttons

Lastly, a map page that visualizes the violent crime location using plotting technique in a map based on longitude and latitude of the violent crime occurred. There are buttons allow user to choose the type of violent crime that users want to display. The plotting will display with circle shape with red color for robbery, grey color for felony assault and chocolate color for both crimes as shown in Fig. 12. The first process to plotting map are this model will read all violent crime information. Then, this plotting map will separate by two layers. For the first layer, the map will zoom in to the location and remove other boundaries layer. For example, in this model, map will focus on New York City map only. Then, for the second layer this model will be plotting and marked with the circle shape the location of the violent crime using longitude and latitude. In addition, the type of violent crime will the determine the marked color such as red for robbery and grey for felony Assault.



Fig. 12. Plotting map in visualization violent crime analysis model

V. SYSTEM TESTING

A. Usability Testing

Testing is an important step in the development of technology to improve the quality of the system. Thus, the 51 user testing consists of the community and the Royale Malaysian Police all ages in Malaysia. This technique can be concluded as significant and to achieve users' specific goals.

1) Usability Testing Data:

The NYC data is tested either can or cannot be used in this study to replace violent crime in Malaysia by user testing. The option answers for the user testing are yes, no or maybe. Majority of the respondent thinks NYC data able to used in this study and the rest respond maybe or no as shown in Fig. 13.

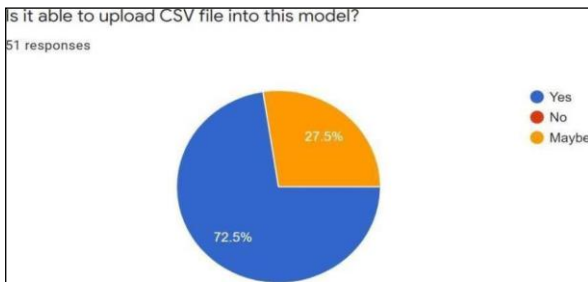


Fig. 13. Percentage of respondent opinion according to the NYC data used

2) Usability Testing Analysis:

At the analysis phase, the tester was be asked about the model either able or not to display a bar chart and pie chart according to the features that user select. In addition, was be asked the ability of the user to identify the frequency and trend from the bar chart and identify the percentage in the pie chart. Also, 94% of the respondent able to identify the frequency and a trend by bar chart as shown in Fig. 14. Besides, 58% of the testing user rated five (strongly agreed) of convenient users to use in the analysis phase, 28% rated four (agreed) and 14% rated three (moderate) as shown in Fig. 15.

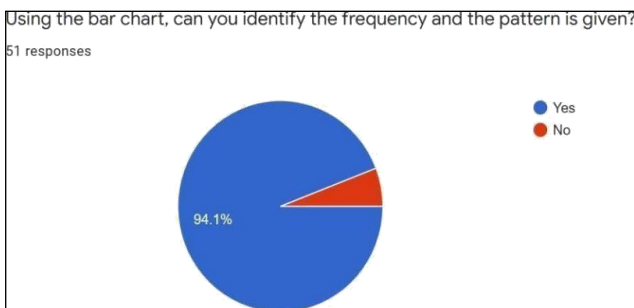


Fig. 14. Percentage of respondent able to identify the frequency and pattern from bar chart

3) Usability Testing Plotting Map:

In this phase, the usability of the plotting map was be tested by user testing. Fig. 16 shows 46 of respondents able to identify the location of violent crime after viewing the plotting map.

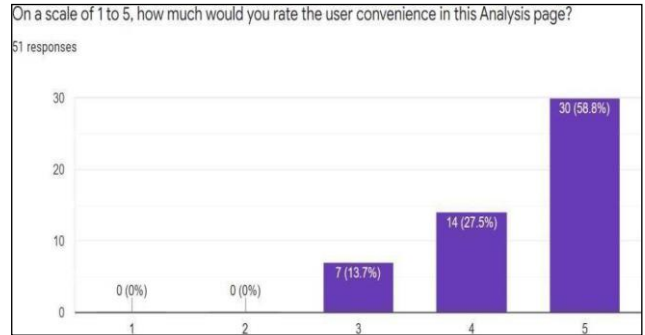


Fig. 15. Rate of user convenient in the analysis page

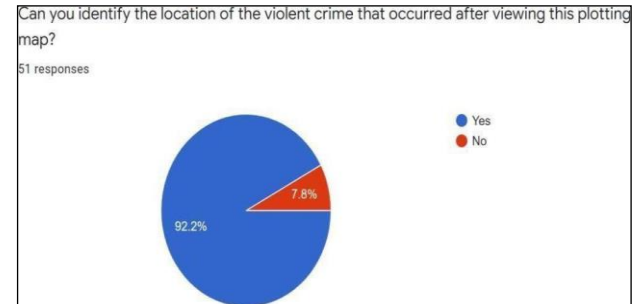


Fig. 16. Percentage of respondent able to identify the location of violent crime

4) Overall of Visualization Violent Crime Analysis Model Testing:

This phase was be asked the overall of the model. 49 respondents agreed this model able to use as the model that helps community and RMP in the future and 42 respondents agreed this model was give a positive impact to the community and RMP to combating the crime as shown in Fig. 17. For overall of this model, 26 respondents rated five (highly agreed) of user ability and convenient to use this model, 18 respondents rated four (agreed) of user ability and convenient of this model and 7 respondents rated three (moderate) of user ability and convenient of this model.

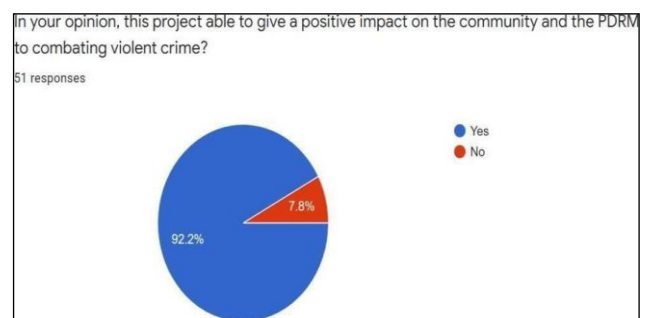


Fig. 17. Percentage of respondent about the positive impact of the model on the community and RMP

VI. CONCLUSION AND RECOMMENDATION

The main purpose of this study was to develop a data visualization model to give awareness and useful information for the community and the Royale Malaysia Police to combat the crime. Thus, this model was be used by the community and the Royale Malaysia Police. This model analyses the violent crime data by using the descriptive analysis to find the

percentage and the frequency after the data cleaning had been made. In addition, visualizing a plotting map which plotting and gives information in every location of violent crime occurred was employed in this model. If this model is revealed to the public for community concerns, this Visualization Violent Crime will help to identify spotlight for specific crime location and highlight high-violent crime areas, as well as assist the Royale Malaysian Police for fighting the violent crime. Hence, the Royale Malaysian Police will improve the effectiveness for fighting the crimes and easy to handle them in the future.

However, this model has several limitations such as data used in this model was violent crime dataset from New York City due to the lack of data provided from resources in Malaysia. Therefore, the process in the data preparation may be affected. Besides, this model accepts CSV file only and the analysis of the data is limited since this model only visualizes the frequency and percentage of the cases.

There are also several areas for further development in this model. One of them, it can be automatically inserts the data from the Royale Malaysia Police's system into this model, which also may help the model to analyse and visualize the violent crime data in real-time. Next, adding more types of analysis to give users good quality information, such as finding average, mean and median. Furthermore, adding more filter to the plotting map which can help the users to observe the violent crime location easier. For example, plotting the location based on week or month only

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