Temasek Defence Systems Institute

IDENTIFYING PROBABLE MARITIME PIRACY EVENTS USING MARITIME INCIDENT DATA

Author: Yeo Jun Yi
Thesis advisor: Prof Robert Koyak
Co-advisors: LTC Ross Schuchard

Background: Maritime piracy refers to the act of forceful boarding or hijacking of ship for various criminal purposes, such as theft, kidnapping, and ransom demands (United Nations Office on Drugs and Crime 2010). Piracy incidents have been reported globally, and these incidents post significant maritime security threats to the international shipping industries.

Objectives: This study seeks to answer two main questions through utilizing data analysis techniques.

1. To measure the effectiveness of time series models to forecast incident occurrences.
2. To identify prominent piracy hotspots clusters across the globe in the past decade.

Dataset: International Maritime Organization Global Integrated Shipping Information System (IMO GISIS) - Piracy and Armed Robbery Data, with period from 1 Jan 2010 to 31 Dec 2022.

Time Series Analysis:

Table 1. Time Series Model Performance Comparison

Model	1-step MAPE	12-step MAPE	1-step MASE	12-step MASE
Naïve	0.40	0.39	1.00	1.00
Seasonal Decomposition	0.39	0.43	1.10	1.10
HW Exponential Smoothing	0.39	0.41	1.00	1.10
ARIMA	0.31	0.35	0.78	0.87
Ensemble	0.32	0.36	0.84	0.92

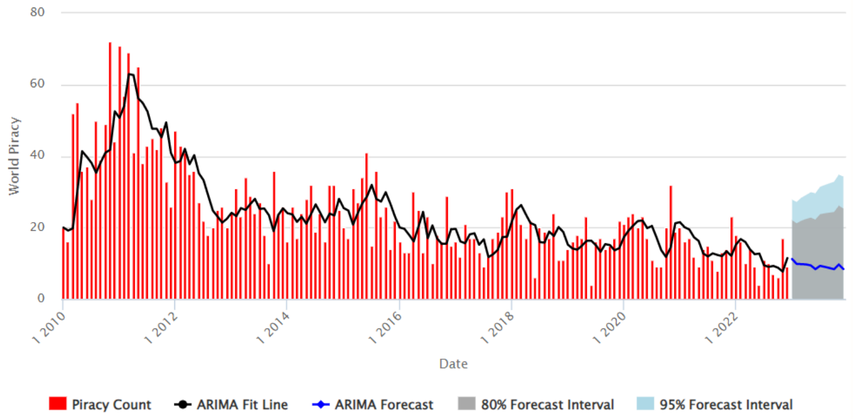

Figure 1. Forecast of Piracy Incidents in 2023 Using ARIMA Model

Table 2. MAPE of Forecasted Results against Reported Piracy. Adapted from ICC IMB (2023b)

Month	Actual Number of Reported Piracy	Forecasted Number of Piracy	MAPE
January	8	11.18	0.397
February	8	9.81	0.226
March	13	9.75	0.250
April	15	9.67	0.355
May	7	9.41	0.344
June	14	8.35	0.404
		Average MAPE	**0.329**

In time series analysis, five different models are evaluated. Although ARIMA emerges as the optimal model in our study, the MAPE of 31 percent from modeling and MAPE of 32.9 percent when compared with actual reported numbers in first half of 2023, the result is relatively moderate and falls shorts of being considered as a highly accurate prediction model.

Clustering Analysis:

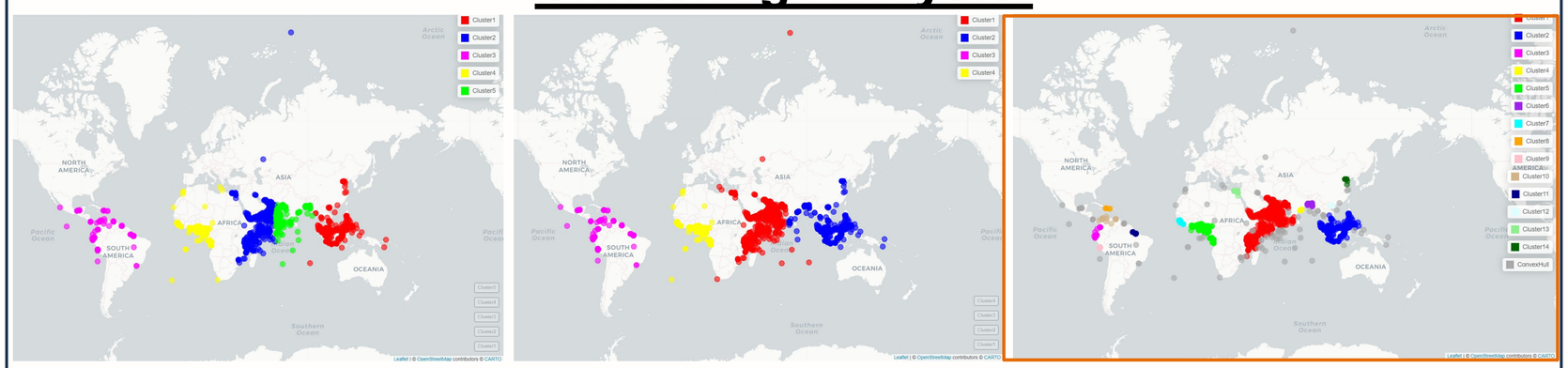

Figure 2. Clustering Algorithm Plots of K-means Clustering (Left), Hierarchical Clustering (Center) and DBSCAN Clustering (Right)

To select the appropriate clustering algorithm in geospatial analysis, we consider the nature of our geospatial dataset and how each algorithm differs in results generated. With the use of Haversine distance for the calculation of distance matrix in clustering analysis, DBSCAN clustering algorithm is selected for being able to remove noise and serve to identify piracy hotspots of varying densities across the globe. Furthermore, DBSCAN can handle the clustering of irregular shape of data points which can conform to the natural coastal line, making it an excellent choice for geospatial analysis.

Spatio-Temporal Analysis:

Spatio-temporal analysis in maritime piracy involves studying the interplay between time and space factors to identify incidents cluster across time and allow us to understand factors influencing piracy. This aids in the identification of global piracy hotspots and the changes in concentration over time and may allow us to evaluate the effects of certain policy changes in the region. Decision makers can focus their attention on identified prominent piracy hotspots and discussed the necessary intervention and initiatives to counteract piracy events.

Prominent hotspots, such as Caribbean Sea, Gulf of Guinea, Gulf of Aden and Arabian Sea, Bay of Bengal, and South East Asia, require more attention over the period of 2010 to 2022. With the rising trend in Singapore Straits, there is a need for enhancing of maritime security measures and effective strategies, such as international and regional collaboration, to be put in place to help raise awareness and combat against piracy incidents.

Conclusion: With use of time series and clustering analysis, it enables us to examine piracy hotspots, predict incident occurrences and identify potential influencing factors of maritime piracy events. This study enhances the understanding of maritime security through data-driven insights and future research possibilities.

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