# Marine Traffic Risk Assessment Using Spatio Temporal AIS Data in Makassar Port, Indonesia

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**Abstract**

*Makassar Port plays an important role in the Ministry of Transport goals of hub and spoke and made a huge impact to reduced economic disparity between eastern and western portion of Indonesia. As an important Port, the safety of the port and the marine environment must be protected at all costs, thus MoT already has established VTS to observe and supervise the daily basis of inbound and outbound ship in Makassar Port. To enhance the safety of the operation, this article will discuss about the utilization of AIS past data to assess hazard area that VTS and harbour master needs to pay their attention at the uttermost level. Using 7 days of AIS past data and QGIS software, we are then able to obtain density using number of points per grid cell function.*

*Keywords:Marine Traffic Risk Assessment; Makassar Port; QGIS, Density Map, Heatmap*

## 1. Introduction

The development of Makassar Port, particularly the Makassar New Port (MNP), has been a subject of extensive research and strategic planning. Several studies have focused on various aspects of the port's development, including ecoport management, capacity utilization, and integration with transportation modes (Haryani et al., 2023; Thamrin et al., 2022). The strategic importance of the Makassar New Port in supporting international trade and transportation connectivity has been highlighted (Lestari, 2021; Syamsiah et al., 2021). Additionally, the role of feeder ports, such as Tanjung Ringgit Port, in supporting the main port and the program of sea tollways has been emphasized (Humang et al., 2021). Furthermore, the development of the port has been linked to the acceleration of the Eastern Indonesian Region's development (Syamsiah et al., 2021). The sustainable development of ports, including environmental sustainability and green port concepts, has been a growing concern in the industry (Acciaro et al., 2014; Chiu et al., 2014; Pavlic et al., 2014). The impact of digital economy on economic growth and development strategies, particularly in the post-COVID-19 era, has also been recognized as an important factor (Zhang et al., 2022). Moreover, the potential cargo demand and the role of ports as international hub ports have been subjects of analysis and strategic planning (Sinaga et al., 2018). The historical significance of Makassar as a strategic port city with established commerce networks has been acknowledged, emphasizing its role in regional and international trade (Musyaqqat & Pradjoko, 2020; Sutherland, 2001). The economic and regional development effects of transport infrastructure, particularly in the context of trade gateway regions, have been studied, highlighting the importance of port infrastructure development (Ishikura, 2020).

In conclusion, the development of Makassar Port, particularly the Makassar New Port, is a multifaceted and strategically significant endeavour that encompasses various aspects such as ecoport management, sustainability, regional economic effects, and historical significance. The research and strategic planning conducted in these areas provide valuable insights for the sustainable and strategic development of the port, aligning with the broader goals of regional economic development and international trade connectivity. But something was missing.


F. Pusriansyah et al. (eds.), *International Conference of Inland Water and Ferries Transport Polytechnic of Palembang on Law, Economic and Management (IWPOSPA-L&EM)*, Advances in Economics, Business and Management Research 290,
https://doi.org/10.2991/978-94-6463-486-0_22

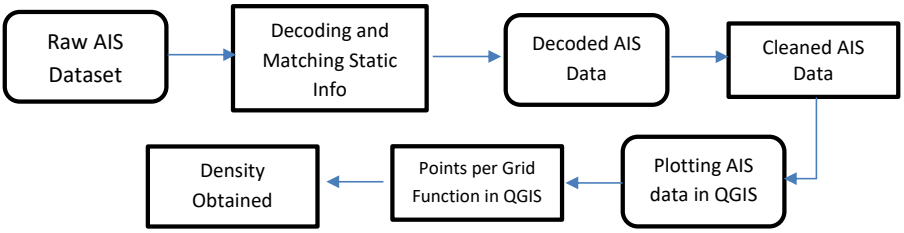
There were no any publication found related to the safety of the ship related to their interface from and to the port of Makassar.

## 2. Research Method

The method of spatio-temporal analysis using AIS (Automatic Identification System) data has been a subject of interest in various fields, including maritime studies, computer science, and medicine. AIS data, which provides information about vessel movements, has been leveraged for spatio-temporal analysis to understand vessel behaviors, detect patterns, and support decision-making. In the maritime domain, studies have utilized AIS trajectories to discover vessel spatio-temporal co-occurrence patterns, enabling the differentiation of vessel behaviors in terms of space, time, and other dimensions. Additionally, the application of AIS data in analyzing collision-avoidance patterns using AI-based methods has been explored, demonstrating the potential for effective learning of ship encounter data.

In the context of medical research, AI and machine learning methods have been employed to analyze medical imaging data, such as PET/CT scans and retinal photographs, for the detection and prediction of diseases, including lymph node metastases, glaucoma, and cerebral ischemia. These studies highlight the potential of AI in processing and analyzing spatio-temporal medical data for diagnostic and predictive purposes. Moreover, the application of spatio-temporal analysis methods using AIS data has been extended to other domains, such as environmental research and public health. For instance, spatio-temporal patterns of the 2019-nCoV epidemic were detected using nonparametric statistical tests and spatial autocorrelation indexes implemented in Python and ArcGIS, demonstrating the utility of spatio-temporal analysis in understanding the spread of infectious diseases. In summary, the research method of spatio-temporal analysis using AIS data has been applied across diverse domains, including maritime studies, medicine, and public health. The utilization of AIS trajectories for understanding vessel behaviors, the application of AI in medical imaging analysis, and the detection of spatio-temporal patterns of epidemics exemplify the broad applicability and significance of spatio-temporal AIS analysis in various research fields. (Wang et al. 2017; Shi & Liu 2020; Borrelli et al. 2020; Li et al. 2022; Block et al. 2020; Yang et al. 2020)

The methodology summarizes in the table below:




## 3. Results and Discussion

### a. AIS Dataset Static Analysis (7 Days) in Makassar Port

From the collected 7 days AIS data, the traffic of in and out of Makassar Port shown in the table below.

**Table 1.**

Ship Static AIS Dataset Analysis (7 days).

| No. | Category | Total |
|---|---|---|

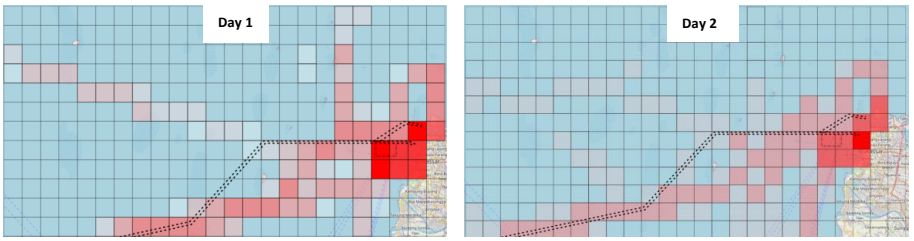
| | | | |
|---|---|---|---|
| 1. | Total number of ships | | 121 |
| 2. | Average number of ships per day | | 35 |
| 3. | Maximum number of ships per day | | 40 |
| 4. | Length of the largest ship | | 230m |
| 5. | Average weight (in GT) | | 47.366 |
| 6. | Maximum weight (in GT) | | 7.622 |
| 7. | Vessel Type | Tanker | 21 (17%) |
| | | Container | 26 (21%) |
| | | LPG Carrier | 10 (8%) |
| | | General Cargo | 24 (20%) |
| | | Bulk Carrier | 12 (10%) |
| | | Passenger (include RORO) | 18 (15%) |
| | | Car Carrier | 4 (3%) |
| | | Other | 6 (5%) |
| 8. | Length over all | -50 | 9 (7%) |
| | | 51-100 | 48 (40%) |
| | | 101-150 | 48 (40%) |
| | | 151-200 | 15 (12%) |
| | | 201-250 | 1 (1%) |
| 9. | Age | Oldest | 50 years |
| | | Average | 22 years |

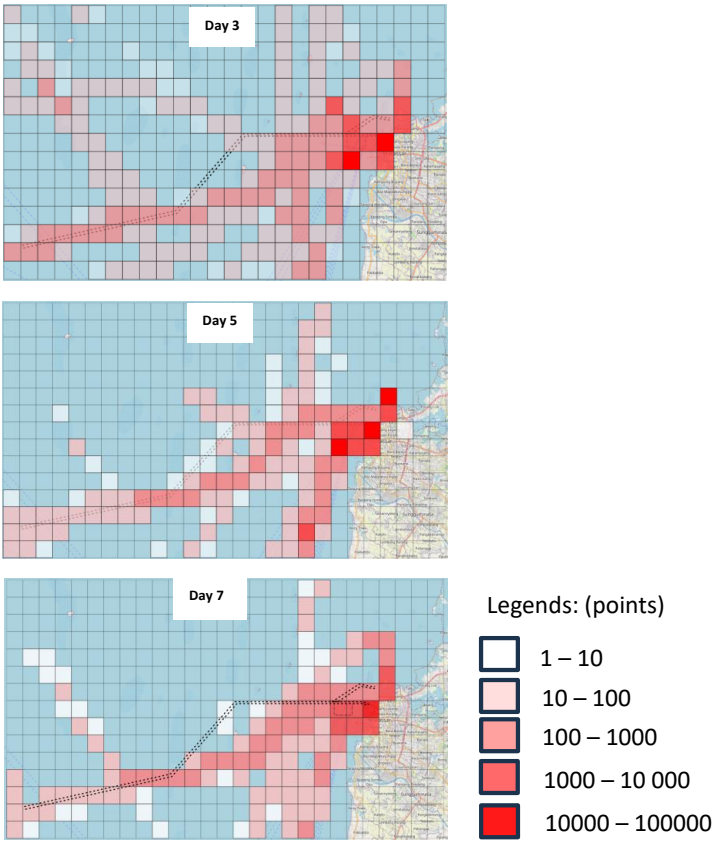
*Source: Decoded and processed AIS dataset, 2023*

With the total of 121 ships passing through the Makassar Port fairway over given period (7 days) and approximately 0.67 ships passing through per hour. Tanker ship and LPG carrier combined (25 %), container (21 %), general cargo (19.9 %) and passenger ship (16 %) were the ship with the highest number of passages through the fairway. The largest ship was 230 meters Bulk Carrier and 80 % of the traffic consist of ships around 51-150 meters length. The average ship's age is 22 years old with the oldest one is a 50-year-old cement carrier.

**b. Makassar Port Traffic Density – Spatio Temporal AIS Data Analysis**

Marine traffic density is a critical factor in understanding the impact of human activities on marine ecosystems. Several studies have focused on analyzing marine traffic density and its implications. conducted a study in the Eastern Mediterranean Sea of Turkey, where they retrieved two years of monthly marine traffic density data, indicating an average density of 0.37 hours of monthly vessel activity per square kilometer during the study period (Awbery et al., 2022). This demonstrates the quantification of marine traffic density in a specific region. Furthermore, utilized automatic identification system (AIS) big data to extract density-based maritime traffic routes, employing kernel density estimation (KDE) based on a geographic information system (GIS) (Lee & Cho, 2022). This approach provides a method for analyzing and visualizing marine traffic density patterns. In addition, reported significant sulfur and nitrogen oxide emissions from global marine traffic, highlighting the environmental implications of high marine traffic density (Langella et al., 2016). The result of the analysis as follow:






Density of Ship in Makassar Port from Processed AIS Dataset

## 4. Closing

### a. Conclusion

The density analysis of Makassar Port suggests that there were several areas that needs to be considered about the ship's traffic especially in adjacent waters of Makassar Port. The coastal traffic seldomly crossing the fairway and many ship visiting or leaving Makassar port did not adhere to the fairway as specified by the regulations.

### b. Suggestion

1) Harbor Master
   The regulation of the main fairway for entering and leaving Makassar Port needs to be clarified and be informed to all ships to always adhered to the given fairway in order to maintain safety of the ships and the environment.
2) VTS Operator
   As suggested from the AIS data analysis, the anchorage area and interaction between ships traveling in the fairway and the local traffic must be observed carefully due to those traffic will be meeting frequently in crossing situation

**Acknowledgments (If Needed)**

Thank you Rahimuddin, S.T., M.T., Ph.D., for the valuable AIS Data so that we were able to decode and analyze the data furthermore

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