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Vessel Monitoring System (VMS) Technology as a Management Strategy for Longline Tuna Capture Fisheries in Benoa

Putu Ristia Amandari[1*], I Ketut Wija Negara[1], Made Ayu Pratiwi[1], Nu'man Najib[2], and Sapto Susilo[2]

[1]Departement of Aquatic Resources Management, Faculty of Marine Science and Fisheries, Udayana University
Badung, Indonesia
[2]Benoa Marine and Fisheries Resource Monitoring Base, General Directorate of Marine and Fisheries Resources Supervision
Pangkalan PSDKP Benoa, Direktorat Jendral PSDKP
Denpasar, Indonesia
*Corresponding author: ristiaamandari@gmail.com

Abstract. Benoa Port has fishing vessel activities that are the foundation of Bali's tuna swamp fisheries (longlines). Sustainable tuna capture fisheries will be impossible to attain if the number of infractions in the marine and fisheries sectors continues to rise. The government's efforts to reduce infractions in marine and fisheries are achieved through tightening the oversight system. The Vessel Monitoring System (VMS) surveillance system was created to reduce breaches in the marine and fishery sectors. The goal of this study is to determine the monitoring and suspected indication of violations of longlines using the VMS at the Benoa PSDKP as well as to learn about the capture fisheries management strategy using VMS data on longlines at Benoa Port using an analytic hierarchy process (AHP) approach. This study used a qualitative-quantitative descriptive technique with AHP analysis to determine the value of the management priority scale. Based on the findings of monitoring longlines with web tracks from January to December 2022, the most targeted fishing area was the Indian Ocean High Seas, and the most prominent suspected indication of violation was the inactivity of VMS when the vessel was operating. The main approach for managing capture fisheries utilizing VMS data on longlines in Benoa Port with the AHP analysis is for the government to offer subsidies for installing VMS on all fishing vessels, particularly those under 30 GT.

Keywords: AHP; Benoa; Longline; VMS

I. INTRODUCTION

The government is developing capture fisheries businesses to utilize the potential of fish resources to enhance fishermen's welfare and the sustainability of fish and their environment [1]. Fishing activities, such as tuna fishing, frequently experience fish theft or actions by fishing vessels that go against the standards stated in the Fisheries Law. That action can be classified as illegal fishing. [2]. Fishing activities without permits in EEZ waters, use of illegal fishing gear, exceeding catch limits, insufficient letter completion, unreported fishing, and fishing on the high seas without regional membership (Regional Fisheries Management Organisations (RFMOs)) are examples of violations in the marine and fisheries sectors [3].

The center of fisheries activity occurs at the fishing port. Benoa Port is one of the ports in Bali that have fishing vessel activities, which are the foundation of the raw tuna (longline) fishery [4]. Sustainable tuna capture fisheries will not be realized if the number of infractions in the marine and fisheries sectors continues to rise. As a result, the Indonesian government began implementing a surveillance system based on the Vessel Monitoring System (VMS) to reduce infractions in the marine and fisheries sectors [5].

A Vessel Monitoring System (VMS) is a satellite-based monitoring system with transmitter equipment mounted aboard fishing vessels or fish transport vessels larger than 30 GT. Implementing VMS can facilitate the supervision and monitoring of fishing vessel activities based on the vessel's position monitored on websites or tracking applications accessible to fisheries supervisors

and ship firms [6]. VMS data can be used as a reference in evaluating the environment and fisheries management since it provides information on the spatial and temporal distribution of fishing activities [7]. Therefore, research was conducted to analyze strategies in the management of tuna swamp capture fisheries (longline) using VMS technology in Benoa to answer the purpose of the study, namely knowing the monitoring and suspected indications of violations of longline with the Vessel Monitoring System (VMS) at the Benoa PSDKP and knowing capture fisheries management strategies through Vessel Monitoring System (VMS) data on longline at Benoa Port with an Analytical Hierarchy Process (AHP) approach.

II. RESEARCH METHOD

Research Location

The research lasted three months, from December 2022 to February 2023. The research was carried out at Benoa Port and the Benoa PSDKP Base. The Benoa PSDKP Base is near the Benoa Sea Area Police on Jl. Raya Pelabuhan Benoa, Pedungan, South Denpasar, Denpasar, Bali.

Methods of Data Collection

The data sources employed in this research can be divided into two categories, which are as follows:

1. Primary Data

Purposive sampling was used to get primary data. Purposive sampling techniques are used based on specific considerations because not all data samples may be used in research. Therefore, they can be tailored to the demands of researchers [8]. The following procedure is performed to collect the primary data:

1. Observation
   Data is collected by conducting firsthand observations of the object of research and other objects in the field linked to the subject under study. The observation was done by participatory observation of longlines with the Vessel Monitoring System (VMS) at Benoa Port.
2. Interview
   Interview activities are carried out to complete the data, as are efforts to get reliable and acceptable data sources. The interview aimed to gather criteria and alternatives for developing capture fisheries management methods. Respondents in this study were drawn from a list of specified key informants. Key informants include the Supervisor of the Benoa PSDKP Base, the Indonesian Longline Tuna Association, the PPN Pengambengan Post, 1 Rawai Tuna Ship Company (Longline), and 1 Rawai Tuna Ship Captain (Longline).
3. Questionnaire
   The questionnaire is a follow-up to the interview data. A pairwise comparison questionnaire will be used in this research. The number of respondents for the pairwise comparison questionnaire was set by the purposive sampling technique used in this research, representing 10 respondents drawn from key informant agencies.

2. Secondary data

Secondary data in this research is ship monitoring data received from VMS tracking, which is monitored through web track by inputting departure and arrival data from the ship. Then, travel flow data from the ship may be presented. Secondary sources include Marine and Fisheries Crime (TPKP) data (2017–2021).

Data Analysis

The data in the research were analyzed using the AHP technique with Expert Choice 11 software, and the results were interpreted descriptively.

III. RESULT AND DISCUSSION

Monitoring and Suspected Indications of Rawai Tuna (Longline) Vessel Violations Utilising the Vessel Monitoring System (VMS) at the Benoa PSDKP

Monitoring the whereabouts of longlines using VMS data from January to December 2022 revealed that the fishing area of longlines located at Benoa Port was largely carried out in the Indian Ocean's High Seas. The fishing area of longlines based in Benoa Port can be determined by tracking actions carried out by fisheries supervisors at the Benoa PSDKP Base. (Figure. 1) depicts the spread of tuna swamp vessel fishing grounds from January to December 2022.

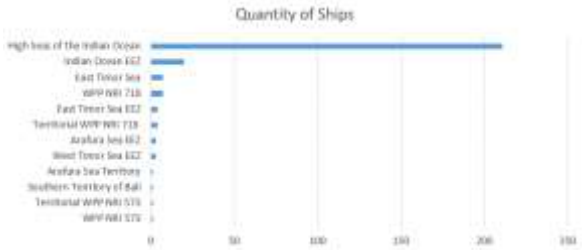

Fig. 1. Distribution of Fishing Areas by Rawai Tuna Vessels for January–December 2022.

The VMS installed and activated on the vessel provides the results of monitoring longlines and other fishing vessels. Based on field observations, the provider's major components of VMS generally consist of VMS antennae, antenna cables, and junction boxes or control boxes. These components are responsible for transmitting signals to satellites and data to the cloud monitoring server network [5]. The data collected from the satellite can be watched in real-time via the web track website, providing a visual representation of the ship's actions. The pattern of fishing

activities by longlines will be clearly shown through a web track that displays data on ship position, direction, and speed, according to the map of Indonesian waters and the world.

The kind of suspected indication of breaches on tuna fishing vessels can be determined using VMS tracking analysis, divided into two categories: inactivity of the VMS transmitter and fishing regions not in line with the Fishing Licence (SIPI). (Figure. 2) The percentage of violation indications is based on a VMS tracking analysis of tuna swamp vessels from January to December 2022.

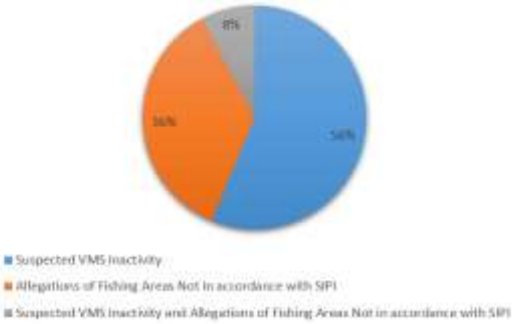

Fig. 2. Percentage of Alleged Longlines Violations in Benoa.

Based on the data collection of vessels suspected of violating based on VMS tracking analysis, the highest suspicion is the inactivity of VMS with a value of 56% or equivalent to 36 vessels indicated to have committed the violation. Allegations of inactivity of this VMS based on interview results may occur if there is a short circuit due to lightning strikes or other electrical problems that cause the junction box on the VMS to lose power. Vessel speed is one of the data points that might be analyzed to acquire suspected indicators of infractions. Hence, VMS activity during fishing is critical. Ship speed data is utilized to identify ship actions such as setting, hauling, soak-time, and steaming [9]. Ship speed, which can be tracked via VMS, can be utilized to analyze indications of infractions. Variations in ship speed in the same location can be noticed if they reflect unusual behavior, indicating possible infractions, such as transshipment activities. Indications of this violation can be seen in suspicious actions in the speed of the two ships when casting, the speed of the ship when towing, the speed of the ship when hauling, and the rate of change in the latitude and longitude positions of the ship so that the movement patterns of ships suspected of engaging in illegal transshipment activities have low speeds [10].

Capture Fisheries Management Strategy through Vessel Monitoring System (VMS) Data on Longline Vessels at Benoa Port with an AHP Approach

The priority matrix of the Vessel Monitoring System technology for managing longline capture fisheries in Benoa is shown in Table 1. The results of the priority matrix obtained are based on data processing using Expert Choice 11 software.

TABLE 1

RESULTS OF STRATEGY PRIORITY SELECTION

No	Strategy	Value	Priority
1.	Optimisation of fishing vessel tracking by providing a special internet connection to access the web track	0,084	P5
2.	Provision of VMS after-sales service that can reach every fishing port	0,119	P4
3.	Provision of subsidies for the installation of VMS by the government for all fishing vessels, especially vessels under 30 GT	0,295	P1
4.	Advise companies in the selection of VMS providers to choose providers with Iridium satellites	0,258	P2
5.	VMS optimization in terms of electrical systems that are adjusted to ship electrical standards	0,243	P3
	Overall Inconsistency		0,04

The research's value for hierarchical consistency or total inconsistency is 0.04. The inconsistency ratio is a metric used to assess the consistency of paired comparisons. The value of the hierarchical consistency ratio found in this study is less than the specified standard, indicating a good or rather consistent level of consistency [11]. The criteria that received the highest priority weight from the assessment results by 10 respondents were VMS subsidies by the government, which is a strategy for providing subsidies for the installation of VMS by the government for all fishing vessels, particularly vessels under 30 GT with a displacement of 0, 295 and the internet connection criterion, which is optimizing the tracking of fishing vessels by providing a special internet connection to access web services.

Providing subsidies related to VMS procurement can refer to the classification of fishery subsidy categories based on effects. These namely ambiguous subsidies help fishermen and lead to sustainable management related to excessive fish resources [12]. Subsidies for VMS

procurement for fishing vessels, particularly tuna fishing vessels under 30 GT, are required so that tuna fisheries management can be more thoroughly controlled because all business actors will conduct transparent fishing activities through monitoring without imposing an undue burden on fishermen in the form of high VMS procurement costs.

IV. CONCLUSION

The conclusions that can be drawn based on the research that has been done are as follows:

1. Monitoring of tuna vessels from January to December 2022 revealed that the most targeted fishing area was the Indian Ocean's High Seas, and the highest suspected sign of violation was the alleged inactivity of VMS when the vessel was operating.
2. The catch fisheries management strategy for longlines in Benoa Port using the AHP technique earned strategic priority, with the government giving subsidies for installing VMS. VMS procurement subsidies for fishing vessels, particularly longlines under 30 GT, are a major priority because tuna fisheries management requires control over all fishing vessels, both above and below 30 GT.

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