An attempt of digitalization Bali Strait purse seine capture fisheries data

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Abstract. Similar situations with most small-scale fisheries globally, data collection remains the most highlighted issues in Bali sardine purse seine fishery. Nowadays, one of the promising approaches in fisheries data monitoring is through a technological application. This study attempts to conduct the digitalization of capture fisheries data through a tablet application development and implementation, namely MICT-L. It develops since June 2018 based on an existing paper recorder system and operated by the fishing-port officer. MICT-L was fully established in November 2018 in Muncar and September 2019 in Pengambengan fishing port, and this system has been collected and store digital landing data successfully. In addition to the initiation, a GPS-trackers system, namely TREKFISH, was installed in November 2019 and successfully collected fishing ground position data from 19 vessels until February 2020. During the study, a total of 8,248 landings in Muncar and 6,598 landings in Pengambengan were collected and stored accordingly. MICT-L and TREKFISH data successfully support the faster near real-time statistical analysis and spatial grid productivity. These two initiations are potent tools for collecting and visualizing digital catch data and fishing grounds for Bali purse seine fisheries.

1. Introduction

Fishery monitoring is one of the critical elements for successful fishery management. Through adequate fishery data monitoring, scientists could acquire scientific data, provide robust analysis, formulate recommendations, and propose management measures to support sustainability and productivity. Indonesia's government continuously increases the quality of capture fisheries data collection through various approaches. Currently, only 70% of the world's total 10,000 fisheries already established a monitoring system [1]. Establishing monitoring and improving data collection through technologies is becoming a vital approach worldwide and technological disruption [2].

Small-scale fisheries dominate Indonesian capture fisheries; the number of small-scale fishing fleets contributes to 96% of the total number of the fishing fleet in Indonesia [3]. In terms of the total gross tonnage (GT) of small-scale fishing boat contribute more than half of the total tonnage, 54% of the capture fisheries total GT in 2014 is small scale fisheries, contributing to the production livelihood is relatively high. However, small scale fishery monitoring and data collection remain a significant challenge; most of the remote area catch is still not being recorded [4].

Bali sardine purse seine fishery is one of the significant small-scale fisheries in Indonesia. The sardine's production from this fishery contributes to the community's high economic as a protein resource, the raw material for canneries, and feed for the mariculture. Indonesia's government enacted
the fisheries improvement plan for sardine's fishery in FMA 573 includes Bali straits in 2016. One of the action plans is to improve data collection and analysis in Bali sardine's fishery [5].

Information and communication technology (ICT) develop rapidly, and the technology becomes more accessible to more vast numbers of users [6]. The roles of technology to support fishery monitoring become wide open in various possibilities. ICT application in fisheries has been initiate in many fisheries worldwide. [1] Conduct an inventory worldwide and create steps and procedures in designing the development of technology in fisheries monitoring. ICT application for fisheries data collection provides digital landing data and enabling automatic data analysis and faster recommendations to achieve sustainable capture fisheries management [7]. This study initiates and proposes data collection improvement through digitalization Bali strait purse seine captured fisheries data, using a digital diary and GPS tracker. Based on the previous experiences in supporting sea cucumber fishery management using digitalization and automatic calculation of capture data in Japan.

This paper describes the result of digital data catch recorder initiation through electronic landing applications, namely MICT-L, combine with GPS tracker data collection to acquire catch and effort data faster and more reliable. MICT-L is a tablet application based on the paper recorder and operated by the fishing-port officer. The GPS-trackers system, namely TREKFISH, is installed on the fishing vessel and automatically transmits position data every 2.5 minutes. Both data are electronically saved in the database system and could be query anytime. These capabilities advantageous to generate the report, provide data to another database system, display the results on a dedicated dashboard, and faster analysis in near real-time.

2. Materials and Method
This study's location was in two major fishing port the Bali Strait, i.e., Muncar fishing port in East Java, representing the west side of the Bali strait and Pengambengan fishing port in Bali province, representing the east side of Bali Strait. Detail map grid arrangement for the analysis of the study area, as shown in figure 1.

2.1. Development of The MICT L Application
MICT-L is an iPad application that records and manages essential information in the fishing port landing/fish market. This tablet application develops on the IOS-based application; the application's layout describes in figure 2.a. There are four fields we can enter to the application: vessel name, fish species, price, and catch quantity, and the total amount automatically calculated. The user's vessel name and fish species list must be prepared to input the application to avoid unnecessary typing errors of the fishing vessel name and fish species. When we tap the ship name during the application operation, it will display the fishing boat list, and the candidates will narrow down in a forward match based on the character selection. Tap a fish species to show the fish species list, and the candidates also will be narrowed down in a forward-match. The amount of total price is calculated automatically from the price and the catch quantity.

The development of the MICT-L application was based on the paper-based landing recorder in Muncar in June 2018. Several discussions and workshops were conducted with fishing port officers to
accommodate the landing data collection needs. After finishing the development processes, the MICTL application was beginning to establish in November 2018 (figure 2.b). Conceptual framework of landing monitoring using the MICT-L application. Landing data collection, storage, and utilization of the MICT-L started from the landing places; officers recorded the catch amount and price by species and individual fishing vessels. The collected data will save temporarily on the devices if there is no internet connection. This temporary data is then synchronized and stored in the cloud-based database server located in the IMRO (Institute for Marine Research Observation) in Bali – Indonesia. Within 30 days, the data could be corrected and verified by the officer, so if the necessary correction is needed, they could make the correction based on the actual condition. Digital landing data collected from MICT-L could easily query for various purposes (reporting, display, and analysis). The database also could be interfaced or synchronized with other database systems (figure 2.c).

2.2. GPS Tracker installation

GPS Tracker, namely TREKFISH, was installed on 19 vessels to collect fishing ground information. TREKFISH device is an affordable GPS Tracker, self-powered using a battery and solar panel instrument. It automatically transmits data from fishing vessels every 2.5 minutes to an online server using a cellular phone internet connection installed in the device. Figure 3 shows the TREKFISH devices and their installation in the fishing vessel.

The transmitted data consisted of vessel ID, date, time, position (longitude, latitude), and dan device battery information. Ideally, we need to install the device on the open and uncovered locations to ensure the solar panel could effectively harvest energy from the sunlight and good cellular network coverage. After the installation, they could access their data movement using their login account on the TREKFISH website.
2.3. Data Structure and Flow Chart
Data from MICT-L consisted of boat name, date, fish species, catch amount, fish price, and total extracted from the database. The data set could be utilized for various purposes (figure 2). In this study, we used the data set for two purposes; first, we conducted a real-time statistical analysis to know Bali Strait's catch status. The second purpose was spatial grid productivity analysis, combined with the GPS data extracted from the TREKFISH database. The database from TREKFISH consisted of vessel_id, date, time, position, direction, speed; using vessel_id, date, and time synchronization, we could extract the complete data set needed for the spatial grid productivity analysis (figure 4).

2.4. Spatial grid productivity
Based on the data flow and analysis process shown in figure 1.b, we performed spatial grid productivity analysis to estimates the number of catches for each fishing location, a total of 348 grids. The grid size was 4 km x 4 km, coded, and assigned following the Bali Strait fishing ground prediction grid provided by Research Institute for Marine Observation (IMRO) in Bali. The grid starts with number 01 and A-letter for the grid in the most west and south grid (01A); the number continues to the east part until 30, while the letter code will continue from A until T to north direction.

![Figure 4. Data flow and analysis process.](image)

We conducted average catch and total catch analyses based on the grid; these analyses combine the catch data from MICT-L with geographical position data provides by TREKFISH. Grid analysis will allow further study of fishing ground verification and spatial density variations. Furthermore, understanding the catch's spatial dynamic is also essential to provide a better fish stock estimation, movement pattern, or migration in response to the oceanographical condition and understand the sardine's life cycle and behavior.

3. Results and Discussions

3.1. Descriptive Statistics Analysis of Landing Record
A total of 8,248 landings in Muncar and 6,598 landings in Pengambengan were obtaining and stored during the implementation until September 2020. We conducted monthly descriptive statistics analysis from the extracted data. The monthly average total catch in Muncar shows continuously decreasing from 2018 to 2020. Different trends occur in Pengambengan. 2020 average total catch is higher than in 2019.

Sardines percentage in Muncar during 2018 was 14% and to 56.4% in 2019 and 76.2% in 2020; sardines catch percentage show increasing trend in Muncar fishing port, a similar situation also in Pengambengan fishing port, sardine catch percentages increase from 40.2% in 2019 to 85.4% in 2020. Previous research from [8-10] explains that during the El Nino, the sardine catch tends to be higher than
the normal or la Nina condition. According to [11], el Nino starts to occur in October 2018 and ongoing to August 2019. Total sardine production in 2019 both Muncar dan Pengambengan port is 14,264 ton and 13,934 ton in 2020 respectively; this production is still bellowed 50% of Bali's MSY level sardine provide by [12].

3.2. Catch Trend, Catch Composition, Vessel Activity and Vessel Productivity

Daily catch trend for sardine and others for Muncar and Pengambengan fishing port show maximum daily sardine production in Muncar fishing port occurs on 2nd December 2019. With the sardine production of 264-ton, the highest daily sardine production in Pengambengan fishing port occurs on 30th March with the sardine production of 421 ton, higher than the maximum catch in Muncar. Fishing season in both fishing ports occurs twice; November – January and end of March to June (figure 6.a). This result still in the range of the high catch period proposed by [13, 14].

Using daily vessel activity in Muncar and Pengambengan fishing port, we could identify the monthly break full month break in both fishing port from the daily vessel activities. Usually, the full-moon break takes 7-10 days, depending on the situation and the captain's decision. Vessel activities in both fishing port also show seasonal variability during the February period (figure 6.b). The vessel activities tend to decrease and increased during December and April, these seasonality activities responsible for the fluctuation of fisheries production [15]. Vessel activities variabilities need to be considered during the formulation of management measures, especially if we consider input control or effort allocation.

Figure 5. Daily catch (a) and daily vessel activity (b) from Muncar and Pengambengan.

3.3. Smart Dashboard

An android application develops to display real-time landing data recorded by MICT-L; we called the application Smart dashboard version 1.0. This application accesses the database and conducts automatic tabulation and performs statistical analysis such as average, data summation based on a daily, weekly, monthly, and yearly basis, resulting from the tabulation and analysis presented on graphical information using Android TV display. Figure 8 shows the smart dashboard display application develop for this study. The smart dashboard display consists of five main tabs/menus i.e., daily information, price information by species, monthly catch, daily vessel activities, and cumulative catch information.

The smart dashboard provides information for both fishers and managers: it will also create a good practice for stakeholder’s engagement and active participation for landing monitoring. The next version of the smart dashboard will display the decision support system (DSS) management recommendation for sustainable Bali sardine exploitation. Participatory automatic analysis and management recommendations will benefit the community (stakeholders) and an excellent way to achieve sustainable fisheries management [7].
3.4. Fishing ground from GPS tracker

GPS position successfully collected from TREKFISH devices, figure 7 shows the results trajectory patterns from fishing operations in November - December 2019 periods, fishing trajectories obtained from the GPS position acquired from TREKFISH. This trajectory information is useful as detailed and near-real-time fishing ground information. If we compare this fishing ground information with previous research conducted [16], [17], and [10], there are similarities of the fishing ground locations.

There is some extent of the fishing ground location from Muncar purse seine fishing ground to Grajakan. Grajakan fishing ground location is on the south coast of Java Island, and the distance is more than 60 km from their fishing base. Fishers tend to temporally shift their fishing ground depend on the situation and catch information from other fishers. Similar with previous study using GPS Tracker in West Nusa Tenggara conducted by [18], TREKFISH GPS tracker successfully visualized the fishing ground for Bali strait sardine fishery.

3.5. Spatial grid productivity

The GPS position from TREKFISH and digital catch recorded data from MICT-L were combined to conduct spatial grid productivity analysis to dedicated 348 grids in Bali Strait. As shown in figure 8, we extracted 46 fishing trips from the study, 30 grids visited during the November – December 2020 study period. Based on each grid's number of visits, grid 25L shows the most visited grid, and grid 25H has the highest total catch. Based on the total catches, this study describes that grid 25H in the western part of Bali strait near Kuta has the highest total catch. The total catch on 25H was 31.169 kg of sardine catch. From the average catch, grid 21N in the middle part of Bali strait near Pulukan Bali has the highest average catch. The average catch on 21N was 17.576 kg of sardine catch.

Comparing the result of spatial grid productivity analysis with chlorophyll and sea surface temperature distribution from a previous study by [13], total catch and average catch distribution have
similar patterns. Strong possibility that two factors are affected the fish distribution and catch productivity. Further analysis on a daily, weekly, and monthly basis could be conducted and overlayed with the other studies such as fishing ground prediction analysis, to provide the ground truth and improve the forecast's validity. In this paper, we limited the research only to total spatial grid productivity. This analysis shows that the digitalization of capture fisheries data acquired from MICT-L application and TREKFISH GPS tracker can provide the information needed for spatial grid productivity and open various research possibilities.

Figure 8. Spatial grid productivity, based on total catch (a) and average catch (b)

4. Conclusion and Recommendations
MICT-L application was suitable for fishing ports or fish markets that handle small-scale fisheries or business entities. MICT-L and TREKFISH successfully provide digital small-scale capture fisheries data for faster time-series statistical analysis and spatial grid productivity analysis. These two initiatives are potent tools for collecting and visualizing digital catch data and fishing grounds for Bali purse seine fisheries. Combining these two initiatives provides fundamental capture fisheries data digitalization, enabling further analysis, i.e., stock status, policy recommendation, and management measures.

In future works, this study will continue until 2022. It will collect more information about detailed fishers, fishing gear, and vessel characterizations. Another approach to increase participatory catch data collection will establish to obtain better catch data. Time-series data analysis provides essential information for Capture Fisheries Management development based on Big Data and Decision Support System (DSS).

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