Design of Prototype Information System for Tracking & Tracing Fish Distribution Based on Mobile Agent

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Abstract. The National Fish Logistics System or often called SLIN is an Indonesian Ministry of Maritime Affairs and Fisheries program that aims to maintain the stability of the production and marketing systems and control the disparity in national fish prices. Central Sulawesi is the Province that becomes the main corridor of this program. The inefficient distribution monitoring process generally causes several problems in the field of fisheries distribution management that still often occur today by the regional Ministry of Maritime Affairs and Fisheries. It indicates that SLIN is not yet running optimally. This study purpose a prototype design of fish distribution tracking based on a mobile agent that can use to help consumers to track distribution channels and get information about the origin of the fish to be purchased. The data will further process for monitoring fish distribution in a real-time manner by the regional Ministry of Maritime Affairs and Fisheries. A proper monitoring mechanism will undoubtedly help the government in making policies and conducting supervision to make the SLIN implementation successful in Central Sulawesi. By the research, we found that the proposed method can gather data from every level fish distribution agent then processed the data to inform about distribution line and the origin of the fish for the consumer. The proposed solution framework could be implemented and nearly fit with current implementation criteria. The framework later can be a base framework for developing a more advanced information system for SLIN in Central Sulawesi Region.

Keyword: SLIN, tracking fish distribution, mobile agent, fish logistic system.

1. Introduction

The National Fish Logistics System (SLIN) is a system formed based on Fisheries Maritime Regulation No. 5 of 2014, which aims to maintain the stability of the production and marketing system and control the disparity in national fish prices. SLIN used as a management system for fishery product supply chains, including materials, production equipment. SLIN also used as information ranging from procurement, storage to distribution as a unity of a policy to increase capacity policies and stabilize fisheries production systems from upstream to downstream, control disparity prices, as well as to meet the needs of domestic consumers [1].

Central Sulawesi is the Province that becomes the main corridor of this program. The main problems in the fisheries sector that are still common today are: (1) the issue of inter-regional fish stock
inequality, (2) monopolization of fish distribution by fish collectors, (3) scarcity of fish stocks in some regions. The problem shows that SLIN is not yet working optimally. The critical aspect of this problem is monitoring, which is not sufficient and efficient, because the methods applied have not been able to improve the efficiency and effectiveness of data distribution from distribution agents to the regional Ministry of Maritime Affairs and Fisheries. It is directly impacting the development of policies that are less accurate and strategic. Previous research conducted by Mubaraq [2] & Rombe [3] revealed a conceptual model of how information systems play an essential role in improving operational performance and distribution of fish logistics. According to them, the integration of information systems in logistics distribution operations as a traceability system can develop distribution schemes so that they can support various management policies and the satisfaction of buyers as consumers. The use of monitoring and tracking system is essential to reduce costs and smooth identification of bottlenecks and operation defects [4]. Most of the existing tracking techniques use RFID (Radio Frequency Identification), GPS (Global Positioning System), NFC (Near Field Communication), RTLS (Real-Time Locating System) [5].

Rombe [3] depict several requirements to implement a fish distribution trace & trackability system in the Province of Central Sulawesi, such as the system must be comfortable and inexpensive to implement and operate. The system must be able to adjust to how the distribution entity behaves. In other words, the system must be able to facilitate integration between the entities of the distributing entity.

2. Related Work

The implementation of the traceability system involves two main principles, namely tracing and tracking [6]. Tracing is the ability of the system to trace the origin of fish, while tracking is the ability to locate the fish after they are caught [7]. Traceability acts as a link to share relevant information between actors in the supply chain [8]. Currently has been several studies conducted related to food tracing & tracking information systems, including research conducted by Shamsuzzoha [9], Egharevba [10], M’hand [11], and Purwandoko [6]. There are several technologies commonly used in tracing and tracking systems such as GPS, GTIN, RFID, Barcodes, Q.R. Code, Cloud Server, and WSN [9-12][6]. GTIN, Barcode, Q.R. Code, and RFID are generally used as item identification media to track objects. The technology is capable of storing large amounts of data in small data formats. They offer labour savings, speed, and cost savings, among other benefits. Barcodes and Q.R. Codes are the most affordable and commonly used devices on a variety of electronic devices, specifically for the latest generation of smartphones [11]. Barcodes have limitations in terms of code readings that are longer and more complicated when the physical label is imperfect or damaged. Moreover, the Q.R. Code can store more data than a barcode [13][14]. Some system designs are suggested in several studies using GPS-based technology integrated into an autonomous IoT system based on Wireless Sensor Network [5][13][12]. The basis of such a system design is not following the implementation criteria mentioned by Rombe [3]. Using a self-contained system that works on a WSN network is too irrelevant to be realized as a Fish tracking & tracing system in the Province of Central Sulawesi because of being expensive, and the technology also requires a framework and policy readiness from the parties. Besides, the mechanism of fish distribution in the Central Sulawesi Province does not yet have a distribution warehouse, so the distribution channels are not fixed and randomly. The proposed design depicts the potential use of several technologies such as Q.R. Code, GPS, cloud storage, and cellular networks that used as a technology base for designing fish tracking & tracing systems for the Province of Central Sulawesi. The idea is the distribution agent works as a sensor node by using a smartphone where interaction between nodes can do using a Q.R. Code so that the node can identify each other along with the object transacted, then use GPS for tracking distribution data. Data storage and synchronization between the distribution node to data-centre done by cloud and cellular-network technologies. Our hypotheses With this simplified design of the use of technology, the system design will meet the implementation requirement of the fish tracking & tracing system in Central Sulawesi Province.

3. Proposed Method

The proposed solution is to build a fish tracing & tracking system based on the Android mobile application. The proposed solution is utilizing QR-Code technology to identify transaction objects and
transaction actors, GPS to identify transaction and fishing locations, cloud database for storing and processing information and cellular network technology for data synchronization needs. The proposed solution only requires a smartphone connected to the internet, built-in camera, and GPS as an operational device for all distribution nodes. All transaction processes from the fisherman, distribution agent, and the retailer will be recorded by the developed application for further data processing to get the tracing and tracking information of a fish commodity.

3.1. Research Method
The research is base on a case study conducted by Rombe [3]. Furthermore, after the problem was successfully mapping according to the apparent characteristics, a literature study was conducted on several technical papers to get an idea of what solutions might be applied to overcome the problem. The technical paper will be reviewed in the form of a simple review to compile a conceptual solution and technology used. The solution abstraction is further described in the form of UML diagrams to illustrate system interactions and tracing algorithms. Furthermore, the system abstraction realizes in the way of an android-based mobile application. Then the operation of the system will be tested to find out how accurately the system able to track fish distribution lines from the sea to the consumers. The research process depicted, as shown in Figure 1. The testing mechanism carried out by using a Black Box method—this method used to evaluate the software to identify a malfunction and a bug [15].

Black box testing considers the value of inputs on a study [16] and ignores the internal mechanisms of a system [17]. Our case definition is the ability to record catching and transaction data from every agent and the ability to track the distribution line and the origin of the fish.

3.2. Distribution Model
Distribution models were obtained based on research conducted by Rombe [3]. The distribution model depicted, as shown in Figure 2. The distribution model involves five actors (distribution agents), namely fishermen, collectors, wholesalers, retailers, and exporters. The model proposed that the fish distribution channel in Central Sulawesi has three distribution models. Through Wholesalers and then to retailers or from collectors directly to retailers. The proposed system built by adopting the three distribution models.

3.3. System Abstraction
The proposed system has several actors who interact with this system, such as fishermen, exporters, and distributors. Distributors generally consist of collectors, wholesalers, and retailers.
The proposed system can accommodate multi-level distributors such as in specific scenarios to ensure the availability of wholesaler stock must transact with fellow wholesalers or retailers with fellow retailers. Given that there are no rules relating to explicit distribution schemes from the local government so that the distribution model can be very dynamic. The proposed system consists of two different apps; it is an app for distributors agents and apps for consumers. The apps for consumers is built-in with fish tracing and tracking features. System interaction for distributor agents depicts, as shown in Figure 3 and system interactions for consumers, are represented, as shown in Figure 4.

Figure 3 shows the main features contained in the system for distributor agents. Each actor in the distributor agent has a wall to display the transaction history. The proposed system also allows fishers to input data even when they are not connected to cellular networks while in the ocean. The proposed system utilizes an integrated camera on a smartphone to read the Q.R. Code. Each entity, such as a fish commodity and distributor agent, has its unique Q.R. Code that is used to identify each other during the transaction process. Several different levels of users use the distributor agent system. Therefore access to the user pages must be through a user authentication mechanism first. The consumer system does not need an authentication mechanism, so the consumer only needs to activate the application. The mobile camera will be active so that it can use to scan the Q.R. Code for fish that is found on the market. Furthermore, the system will run the tracing & tracking algorithm based on the fish.
transaction history and display the distribution channel mapping starting from the catch point to the point of sale on an electronic map on the mobile device, as shown in Figure 4.

3.4. Distribution Tracking Algorithm

Each fisher generally packs fish in a certain quantity, and then the fish package is then given a label in the form of a Q.R. Code. Furthermore, the data of the fish in the box, along with the Q.R. data, is recorded to the system. The consumer’s system triggers the tracking & tracing process. The assumption is that when a fish commodity is on the market, it means that the product has gone through a distribution process. To enable the tracking of distribution channels, every time a product moves from one distributor agent to another, the data recorded by the system is the coordinate transaction data, transaction timestamp, transaction data agents (sellers & buyers), and commodities that are transacted. Based on this data set, the tracking algorithm will search the data tables in a database to get a distribution line from upstream to downstream. The system uses the timestamp to sort the transaction history, then draw the transaction point and direction on the map. Tracking the origin of fish catches is done by allowing fishers to record the coordinates and time of the catch when still in the ocean—the data stored in a local database on the mobile device. When fishers arrive on the port, the fishers then pack fish into the fish box and then input the fish data, Q.R. Code, along with the time and coordinates of the fish caught in the system. Then the system will synchronize data to the cloud. The catch time will be a benchmark for determining how long the fish have been caught. Tracking & tracking algorithm flow described in Figure 5.

Fig. 5. Fish Tracking & Tracing Algorithm.

4. Result and Discussion

This section presents the result and the implication of the proposed method. Before the distribution lines traced, the proposed system requires distribution chain data as a reference. In our test scenario,
fishers catch fish on the coastline of Donggala Regency. Every time a fisherman makes a catch, a fisher can record the coordinates of the location and time of the catch by utilizing the Global Positioning System (GPS) device integrated on a smartphone, as shown in figure 6. The recorded data is stored temporarily on the smartphone as a reference for the location and time of fish catch. After the fishermen arrive at the port, the fish they catch then grouped into fish boxes, and then each fish box is labelled with a QR-Code. The fish box then recorded in the system by adding a reference in the form of fisherman data along with coordinates and catch time. Each box of fish has the possibility of being purchased by several collectors in smaller portions. However, in our test scenario, the whole fish box is acquired by a collector. When the transaction process carried out, the buyer must scan the fisherman’s QR-Code first, then input the transaction data, including the fish QR-Code box, as shown in figure 7.

Then the collectors carry out further distribution to wholesalers until they reach the final distribution point at the retailer. Each hop of the distribution transaction, the buyer, must record data related to the identification of the fish purchased and the identification of the seller. The system will record the coordinates of the transaction using the buyer’s handheld device. This process will automatically update the sales data on the seller’s side. Consumers who want to check the origin of fish can scan the QR-Code of the fish and the seller (retailer) on the consumer application, as shown in figure 8. This process will trigger the distribution line tracking algorithm along with the location and time of the fish catch, then displayed on an electronic map in the consumer application. Based on our test results, the proposed method can do catching and transaction data from every agent and the ability to track and trace the distribution line and the origin of the fish. Furthermore, we found two things that could cause the system to fail to operate, namely the device’s ability to capture signals from the GPS satellite. It can cause the system to fail to record data to cloud storage if the device cannot lock the coordinate between 5 to 15 meters. Besides that, the timer setup on the handheld device must also be appropriate because otherwise, this could cause the tracking algorithm to fail to find the fish distribution path from upstream to downstream. We also need to carry out further testing of the proposed tracking algorithms in more complex distribution scenarios. For example, when the fish in a fish box identified by one Q.R. Code has branched distribution channels, goods are transacted between collectors and wholesalers. Up to several times before reaching the consumer, this must be done to ensure the algorithm’s behaviour remains consistent in more complex distribution scenarios.
For the regional fisheries ministry purpose at the later work, the fish catch data will be grouped based on the name of the port, the distribution of catch points anchored at the relevant port, the accumulation of fish commodities that distributed at each distribution endpoint. Central Sulawesi Province has two main ports, namely Donggala and Toli-toli Regencies port. Each district represented with a different dot colour. Furthermore, the points depicted in an electronic map on a web-based application, complete with statistical data on fish commodity distribution. The system for these purposes developed further.

5. Conclusion

The proposed system has been able to identify and track the distribution and origin of fish catches. Even though it has previously mentioned that this proposal does not require a significant overhaul of the existing distribution business model, it still needs adjustment. Therefore, the role of the government, in this case, is still necessary to manage the actors and distribution scenarios involving the proposed system. The proposed system has several technical issues related to the use of GPS, which in certain conditions and on specific mobile devices, have difficulty in locking coordinates. This
issue will undoubtedly be quite difficult for the transaction process using the system because transaction data will not be saved to the database if the transaction coordinates cannot be locked. Another thing that is also still a problem is if the time setting on the cellphone does not match the actual time, it can undoubtedly disrupt the tracking mechanism of the fish distribution path. The proposed solution framework could be implemented and nearly fit with current implementation criteria. The framework later can be a base framework for developing a more advanced information system for SLIN in Central Sulawesi Province.

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