Global Journal of Engineering and Technology Advances
eISSN: 2582-5003
Cross Ref DOI: 10.30574/gjeta
Journal homepage: https://gjeta.com/

(RESEARCH ARTICLE)

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Fisheries products traceability using batch code

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Global Journal of Engineering and Technology Advances, 2023, 15(03), 135–149

Publication history: Received on 05 May 2023; revised on 21 June 2023; accepted on 24 June 2023

Article DOI: https://doi.org/10.30574/gjeta.2023.15.3.0111

Abstract

The importance of product quality and food safety for consumers would be reached by apply traceability product. Indonesia's geographical archipelago has long supply chain of fisheries which cause all supply chain data getting difficult to trace from upstream to end of consumer. The problem of this research is how to apply traceability of seafood products from their origin through to end customer by using traceability system. The method used is apply batch code identifier to represent vessel information, catch data, and landing site. System applies automatic detection of landing site coordinates using global positioning system, and along with batch code stored to cloud server. The batch code moved along with the fish movement in each supply chain. Once fish received by processors, system get access cloud server to get proper batch code. Finally, each product is labeled with QR Code containing product information and batch code. While products sent to customers, label scanned and system provide fish origin information and show the maps of the vessel landing location. The testing results shows label can be scanned at maximum distance of 40 cm in dry surface and flat and curved position, and at a maximum distance of 25 cm in flat position, wet and frozen conditions. Label can be scanned at maximum distance 20 cm in a curved position and wet and frozen conditions.

Keywords: Traceability; Batch Code; QR Code; Landing Site; Fish Origin

1. Introduction

The traceability of seafood product's supply chain is important for consumers to guarantee product quality and food safety. Several cases of Indonesian fishery products that were rejected by the United States as evidence of the lack of implementation of food security in Indonesia. The World Health Organization estimates that there are more than 1000 million cases of acute diarrhea annually in developing countries, with 3-4 million deaths[1]. According to the Food Standards Agency (FSA) there are nearly 900000 cases of food poisoning each year[1]. In Indonesia, from January to March 2017 there were documented 23 incidents and 893 people who experienced food poisoning, and in 2017 in Gunung Kidul Regency Yogyakarta there were 79 cases of food poisoning without death with causes of poisoning based on the highest food attack rate and based on the results of the examination laboratory, poisoning is caused by E.Coli and Salmonella bacteria[2]. In several region in Indonesia during 2014 found 186 total case, while in 2015 there were 153 incident, with various cause factor food poisoning, natural poisons, pesticides, mixtures, and environmental pollution[3]. Since 2019 the United States through the Food Supervisory Agency (FDA) applied Seafood Import Monitoring Program (SIMP) for all food products imported from US. SIMP is a program for importing certain seafood products, reporting and recording requirements needed to prevent illegal, unreported and unregulated (IUU, illegal, unreported uncontrolled) fishing or misstatement from entering the United States trade to ensure global food security and sustainability marine resources[4]. Indonesia's geographical archipelago which has longer path of fisheries supply chain to reach end of consumer, and traceability data is difficult to obtain, since it is not supported by adequate information system. Because of longer path of Indonesia's fishery supply chain, it is difficult to record information of fish which is distributed to each supply chain [5]. Traceability is technical requirement in general for businesses to meet government regulations on food safety, food recall, and product labeling from home countries[6]. Based on that

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background, we conducted the research to develop a traceability system for seafood products which purposes is to track the origin of seafood product's information consisting of the vessel name, fishermen, vessel landing site location, and supplier name. The problem of this study is how the step to develop seafood traceability system to help consumer to track the origin of seafood product. This research uses the batch code moves along with the movement of fish in each supply chain stage, and at the fish processing stage this traceability implemented by using automatic identification QR Code label on seafood products. This research also provides solutions for SIMP requirements regarding to export documents of seafood to United States. Quick Response Code is often called the QR Code is a two-dimensional symbol developed by the company Denso Wave, as shown in Figure 1. The purpose of the QR Code is to convey information quickly and also get a response quickly. QR Code is the development of barcodes or bar codes which are only able to store information horizontally while QR Code is able to store more information, both horizontally and vertically[7].

Figure 1 Example of *Quick Response Code*

QR Code has several advantage characteristics, which is having a high capacity in storing data, the small size of the QR Code can store the same amount of data as a 1D barcode and does not require a large space, can correct errors or compensate for distortion[7]

1.1. Related Work

Qijun Wang, et al, (2019) presented Food Safety Traceability System Based on Blockchain and EPCIS. This research background is traditional traceability systems have problems, such as disruption, and disclosure of sensitive information, and blockchain as a promising technology for food safety traceability systems because of its characteristics, such as irreversible time vectors, smart contracts, and consensus algorithms. This research explains the importance of accurately recording, sharing, and tracking specific data in the entire food supply chain, including production, processing, warehousing, transportation and retail processes. [8].

Kurniawan, Aldhi Ari Utomo in (2019) presented QR Code Mobile as a Supporter of Hospital Outpatient File Medical Records. St. Elisabeth Semarang. This study discusses the use of QR Codes in medical records. The lack of system integration between units also causes misunderstanding between users of health services. the possibility of data corruption, loss, and the existence of twin data still exists. The medical record documentation available in the document notes and maps causes problems in health services, requiring waiting times for services for patients, medical staff and doctors. Collaboration with web-based and mobile, QR code is able to handle the problem. Users only use smartphones to browse medical record files for patients, QR codes can be used to trace history during examinations such as diagnoses, examination results, and medications used. The test results, the proposed system is able to overcome the problem of the patient's outpatient medical record file at the hospital. St. Elisabeth. On average more than 50% of respondents stated that the system was good at handling file searches, file completeness, and storage[9].

Rastri Prathivi (2019) presented Analysis of the QR Code system for identification of library books. The book's identity is stored in the library in the form of the title of the book, the author, the ISBN number, the year of borrowing the book, the number of shelves where the book is stored and the number of books available in the library. The identity of the book can be summarized in the QR Code. With the QR Code on the book, users can get information about the book without having to connect to the database, simply scan the QR Code Reader and to make the QR Code require an application generator. In this study, the authors developed a case study of Library of Semarang University. The QR Code Generator converts alphanumeric data from a book into a two-dimensional image that is attached to every book in the library[10].

Eka Putra, et al (2018) presented about design and development of tuna processing information system at PT Blue Ocean Grace International, focused on the tuna processing system from whole products or loin products to 30 Kg frozen loin products, in the fish processing process consisting of receiving processes, cutting, retouching, packing and shipping. By utilizing the information system, the company can manage transaction data properly and users can do a retrace of the final product related to the supplier, the processing date, and the fishing ground[11].

Eka Putra, et al (2018) presented design of fisheries processing information system using quick response Code, which was motivated by the potential for manual data input errors, inaccuracies and data searches that require a long time, difficulties in the search system, the use of lot codes makes it easy to trace the origin fish at each stage of fish processing in the form of tracking species information, grade, product size, weight, country of origin, supplier code, fish processing date and name of the fish processing company[12].

Peng, Yaoqi (2018) presented a QR code-based traceability method for fresh pork quality in cold chain. This study presents a QR code tracking method for a quality pork tracking system combined with the quality of meat from cold supply chains and environmental information collection programs. This method includes a correction recognition test for the final design of the QR code. The results show that the QR code can store a large amount of traceability information, with strong error correction capabilities, and can provide a large advantage in scanning recognition. In the process of consumption, consumers can easily get information on the quality of fresh pork by scanning a QR code with a cellphone, instead of having to choose a piece of meat to buy based only on visual observations of the meat. The resulting QR code is tested in several supermarkets, has a strong error correction ability, and can meet retroactive requirements[13].

Yu-Tso Chen and Ching-Chung Chen (2017) presented improve the performance of traceability system by using a digital certificate enabled anti-counterfeit QR-Code mechanism. This research explains the current traceability system may still have problems such as incomplete recorded data, traceability information is corrupted, thus affecting the practical performance of product traceability. This paper proposes anti-counterfeit QR-Code (AQRC) which provides integrity and non-repudiation functionality for search systems through the adoption of information security schemes including digital certificates and digital signatures. The contribution of the proposed AQRC mechanism is to improve the performance of product traceability operations and implement information security to solve the problem of product traceability. Product traceability is proven well through verifying data in damaged or not AQRC codes[14].

Yeong Gug Kim (2016) presented consumer acceptance of a quick response (QR) code for the food traceability system: Application of an extended technology acceptance model (TAM). The purpose of this study is to apply TAM using the addition of perceived information to individual behavioral intentions to use QR codes for food tracking systems and to determine the effects of moderation on food in the relationship between perceived information and perceived benefits. The results of a survey of 420 respondents were analyzed using structural equation modeling. The research findings reveal that TAM has a satisfactory match to the data and that the underlying dimensions have a significant influence on the use of QR codes for food traceability systems. In addition, food involvement has a significant influence on the relationship between perceived information and perceived benefits[15].

Naaum, et al (2016) presented Seafood Authenticity and Traceability: A DNA-based Perspective. This research explains the DNA-based perspective is a brief reference that shows developments in seafood traceability, discusses the methods used for DNA analysis and an overview of their applications in fish and seafood, also provides a technology and process review for each method that describes the relationship between identification accurate, traceability, sustainability and seafood safety, including an overview of the supply chain and the industry's need for improved search. Presenting current and future perspectives in the field of emergence of search, including strong coverage of DNA analysis[16].

Zhu, Shanhong Tang (2015) presented the design and implementation of eggs' traceability system based on mobile QR code. This study proposes an egg package tracking system consisting of mobile software, database management systems, server systems, also includes egg production, sales information, transportation, confirmation, communication with customer functions according to tracking requirements and tracking food supply chain management and quality and security. The design depicts cell phone client software systems, background data management systems and server database system modules to achieve food tracking management, detailed electronic trace information about food can be asked via web services or smartphones or other devices[17].

2. Material and method

2.1. Research Flow

The initial research flow started with direct observation of fisherman activity during vessel landing, fish handling by fisherman and then delivered to supplier, then after that supplier deliver the fish into processor in processor's point of view called receiving activity, processing, storage, packing of products and shipping to the customer. After have enough information during direct observation, the next stage would be designing general flow system and data flow diagrams, design database and system user interface. The final stage is developing information system, including automatic

detection of the coordinates of the vessel's landing location and system testing. The general flow of research can be seen in Figure 2.

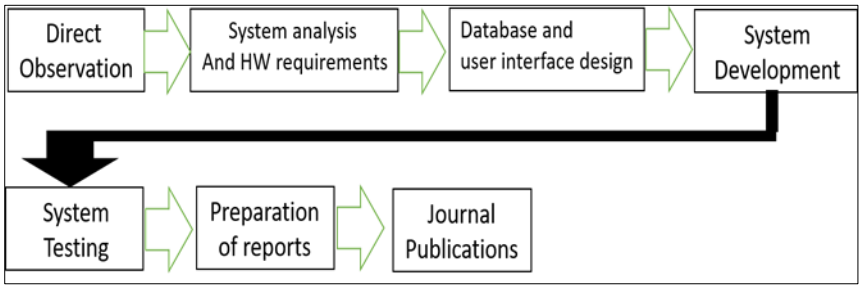

Figure 2 Research Flow

2.2. Research Location

This research conducted in Bitung port, North Sulawesi, Indonesia in one of fisheries processing companies.

2.3. Research Object

The research object is the location of landing site, the catch information which formed as batch code and product packaging. The batch code provides information of the origin of the fish by detecting the geographical location of the fishing vessel landing. Once fish received at the processors, user read batch code / fish tagging and catch information and further processed into seafood products, then take the label into each of seafood products.

2.4. Flow of Seafood Traceability System

The general flow of seafood traceability system can be seen in Figure 3.

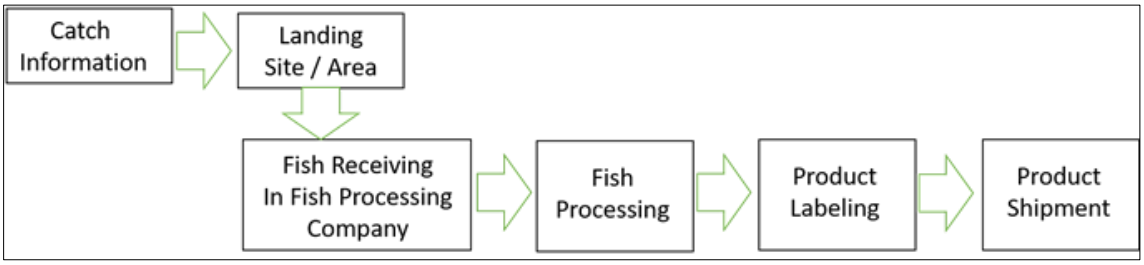

Figure 3 General Flow of Seafood Traceability System

The flow of traceability system starts from recording fishing information, then recording landing location and landing date once vessel landing. Tagging is given into fish which contains fish catch information. The next stage is the recording data of fish receipt from the fish processing unit, processing to packaging the product to be sent to consumers. In Figure 4 explains general description of traceability system starts from the recording of fish catch data consists of the vessel name, trip date, fishing ground, captain or fisherman's name. Furthermore, when the vessel landed, then recorded information consists of landing date and landing location. All data is stored in an online cloud server data including information on the location of the vessel landing coordinates include latitude and longitude. Each fish is tagged the batch code generated by system, which batch code contains information on the vessel code, the landing location and landing date. Once fish has tagging, the fish delivering to the fish processors, once user receiving the fish, the batch code tagging is read by the reader device and verifies the information within the data from cloud server. Furthermore, this batch code tagging is attached into fish and their middle products to follow each stage of processing. Seafood product is labeled with the QR Code format and put into packaging with QR Code label on each packing and ready to ship to customer. Through the use of the QR Code label on the product, the origins of fish from seafood products can be traced fish origin information, the ship landing date, fisherman information, vessel name, and vessel landing location.

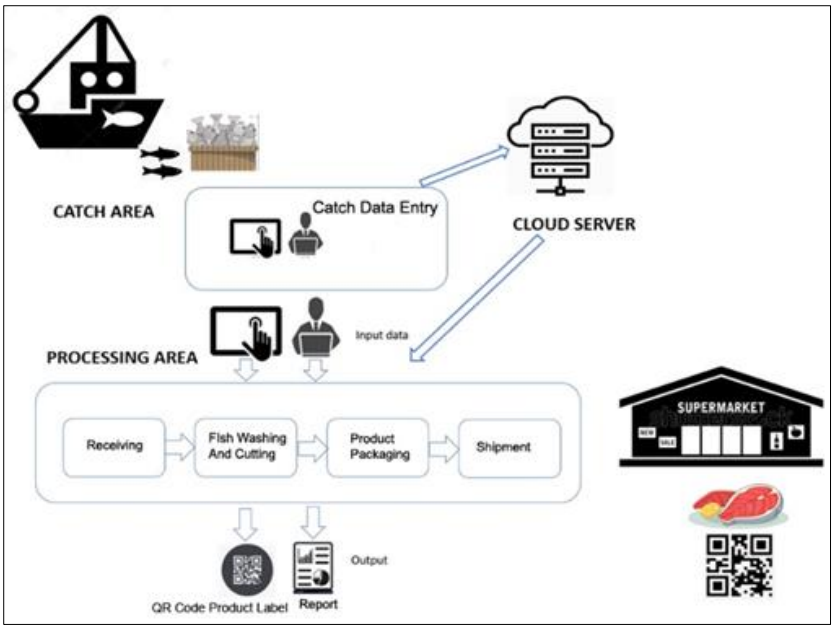

Figure 4 General Description of the Traceability System

2.5. Batch Code Formulation

Batch code is identifier used to track fish origin, while batch code consists of 3 parts, the first part is vessel code, second part is landing area, and the third part is landing date (use Julian date format). Example batch code shows in Table 1.

Table 1 Example of Batch Code

Batch Code : ALD.BITUNG.23122		
Code	**Description**	**Details Description**
ALD	Vessel code	Vessel name: Alta Duri
BITUNG	Landing location	Bitung area
20	Year of landing	2023
122	Date of landing	Julian date: May, 1

The Julian calendar has two types of year, a normal year of 365 days and a leap year of 366 days. We use landing date using Julian calendar format to make date code shortened as parts of batch code. By using the batch code, we could trace landing information of fish and vessel information.

2.6. Technology Used

The design and development of traceability system uses the Visual C # programming language with MySQL database, and utilizes an internet-connected global positioning system to detect locations based on latitude and longitude coordinates.

2.7. User Interface Design

The design of the Catch module user interface can be seen in Figure 5. The Catch module to store fish catch data or fish origin information. This module consists of vessel data, fishermen, fishing ground, trip date, landing date, landing location, vessel landing coordinates. The system will generate batch code as code consists of information of vessel ID, landing area and landing date by using Julian date format.

Figure 5 Catch Module User Interface Design

Receiving module record fish receiving transactions from fishermen or suppliers, which consists of supplier name, vessel name, fishing ground, receiving date, species, grade, loin weight, fish quality (odor). The design of the Receiving module can be seen in Figure 6.

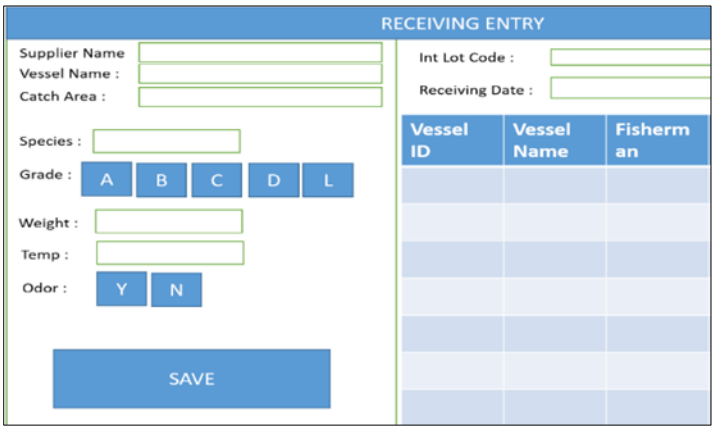

Figure 6 Receiving Module User Interface Design

The cutting module record fish cutting transactions to become products. This module consists of supplier name, cutting date, fish number and loin number. The end result of cutting process is a loin product which is each products put label contains supplier, cutting information and fish origin. The cutting module design can be seen in Figure 7.

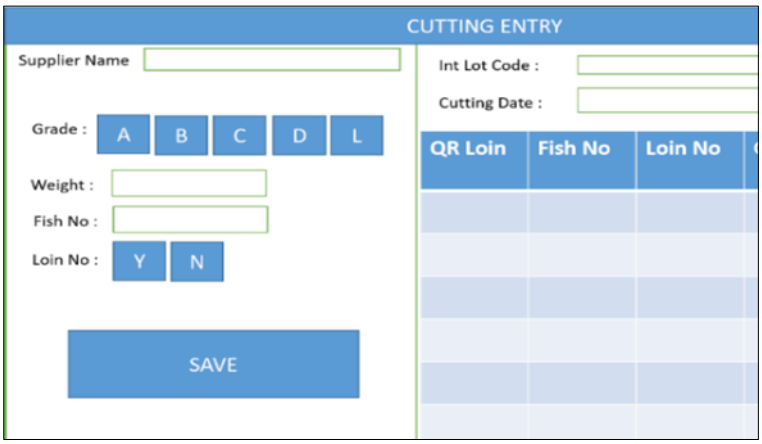

Figure 7 Cutting Module User Interface Design

Packing module is used to save packing transaction data, which is packing use master carton box. This module information consists of box number, grade, packing size, supplier, species, internal lot code, expiry date, pieces and weight. The packing module design can be seen in Figure 8.

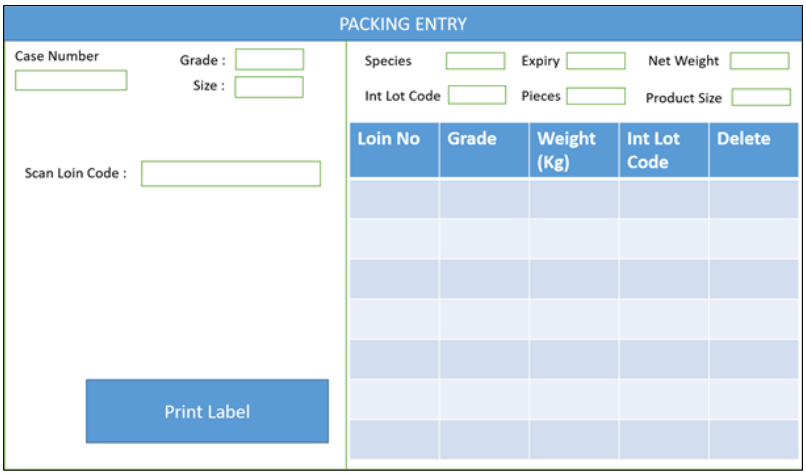

Figure 8 User Interface Design for Packing Module

2.8. Contex Diagram and Data Flow Diagram Design

Design of context diagram can be seen in Figure 9.

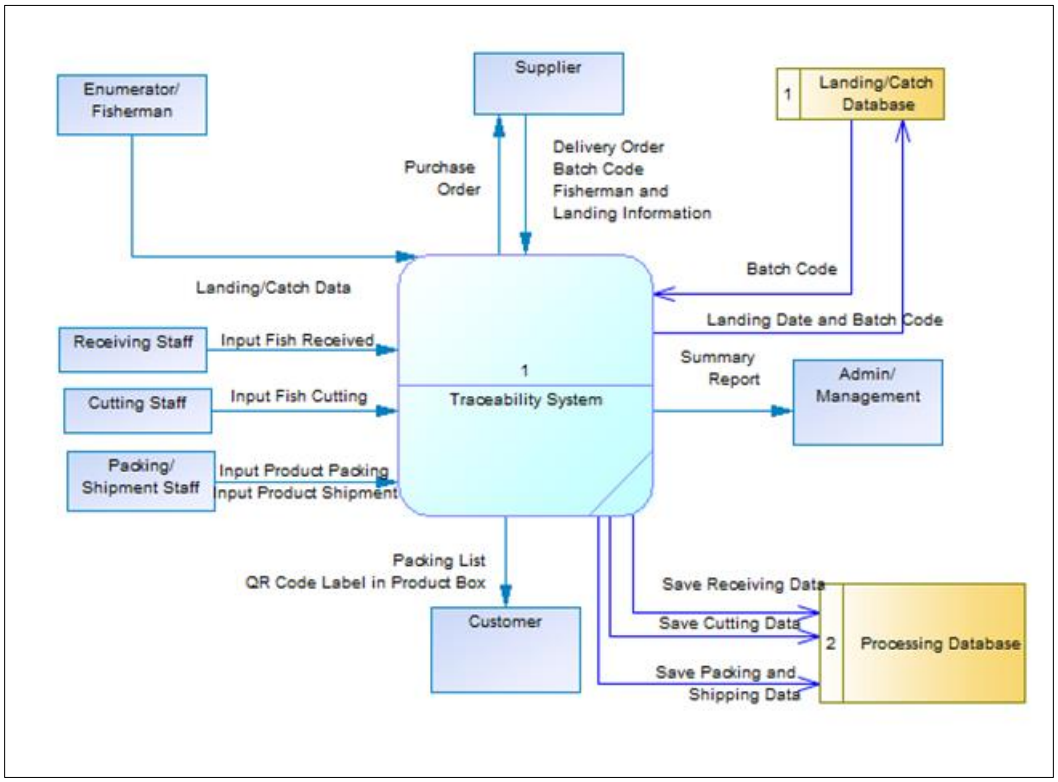

Figure 9 Context Diagram Design of Traceability System

A context diagram contains one process node that generalizes the function of the entire system in relationship to external entities. Context diagram above is composed of 7 external entities, 1 process, and 2 data stores. The entities are enumerator/fisherman, supplier, receiving, staff, cutting staff, packing/shipment staff, customer and admin/management. The arrow represents data flow into system or out from system, where each data flow is shown in the Figure 9. Traceability system as the process of this design, and the data store consist of landing/catch database and

processing database. Catch database is used to save catch/landing data, and processing database is used to save transaction data from receiving until shipping stages. Meanwhile data flow diagram (DFD) shows further level of detail not shown in the context diagram. The Data Flow Diagram (DFD) shows the data flow between the processes within a system. Data flow diagram shown in Figure 10.

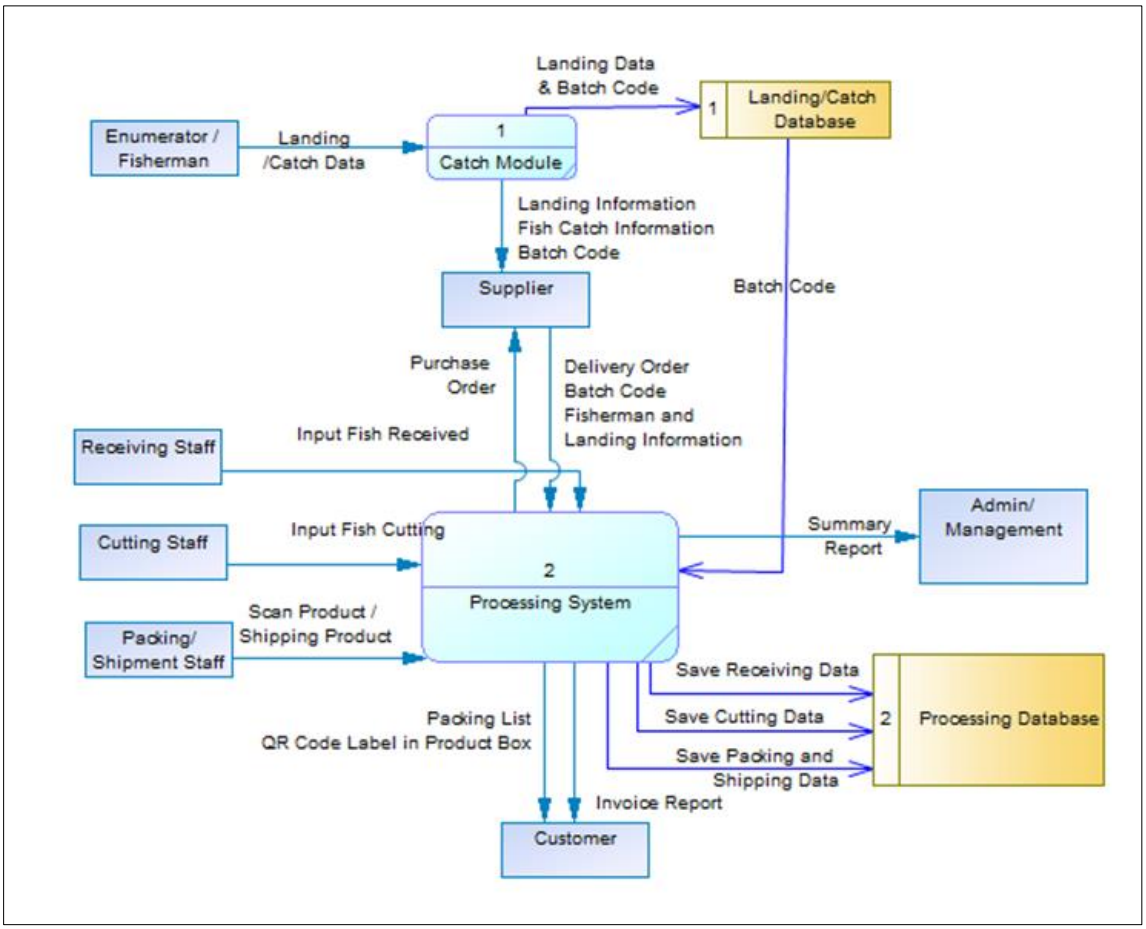

Figure 10 Data Flow Diagram Design of Traceability System

There are 7 entities, 2 data store and 2 process. The arrows represent data flow from entity to process or data store, shown in Figure 10.

2.9. Hardware and Software Requirements

The hardware requirements to implement this traceability system can be seen in Table 2.

Table 2 Hardware Requirement List

Type	Specification	Used For
Server Computer	Server using Windows Operating System	Store transactions in the database
Laptop	RAM minimum 4 GB, Windows Operating System	Entry transaction data on each stage
Label Printer	Barcode label printer	To print QR Code label
QR Code Scanner	2D QR Code Scanner	Scan/Read QR Code label

Table 2 outline the hardware requirements for implementing a traceability system in a fish processing company. While the software requirements are described in Table 3.

Table 3 Software Requirement List

Software Type	Specification	Used For
Web and database server	Apache and MySQL Server	To save fish processing data transactions
Cloud Server	Cloud server with enough storage space, at least 4 GB	To store catch transaction data into the cloud server

3. Results

3.1. System Result

This traceability system user interface consists of user interface of catch module, receiving module, cutting module, and packing module. The catch module interface figures out in Figure 11.

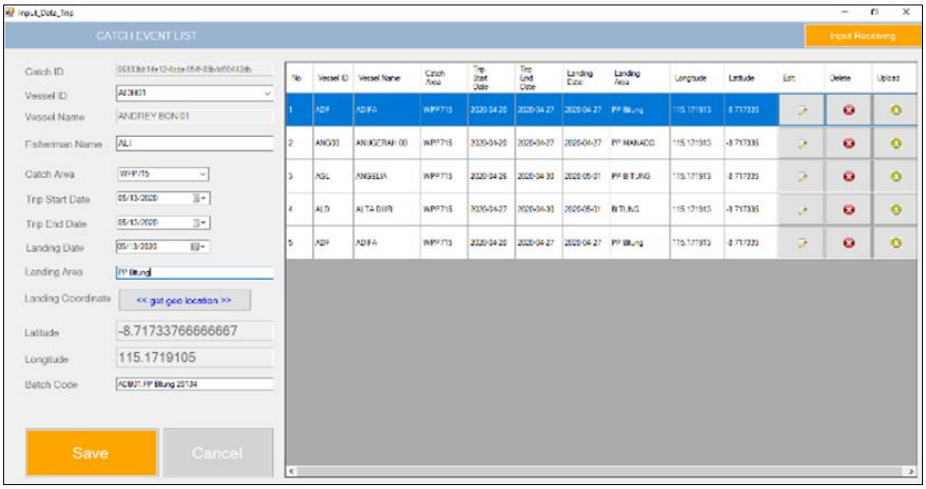

Figure 11 User Interface of Catch Module

Catch module is used to input fish catch data transaction consists of catch area, ship name, fisherman, trip time, landing time, landing location. In the catch module there is a feature to detect the landing location (latitude and longitude coordinates) automatically by pressing the "get coordinates" button, activates the global positioning system from a laptop device and requires to be connected to the internet connection, so that the location coordinates can be obtained in real time. The traceability system generates a batch code for each landing activity that used for tracking code for next transaction in fish processing company. Receiving module user interface can be seen in Figure 12.

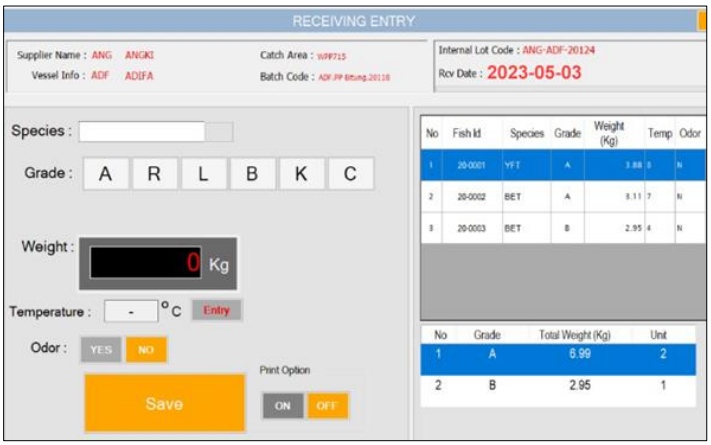

Figure 12 User Interface of Receiving Module

Receiving module is used to manage fish data received from supplier. The system uses batch code tagging in each fish generated from the catch module, which is data element consists of supplier name information, ship name, catch area, receiving date, species, grade, weight loin, fish quality (odor). The cutting module is used to record cutting activity of fish to become loin products, to shape fish to be 4 loin products. This module consists of supplier name information, cutting date, fish number and loin number as unique number identification of products. Cutting module user interface display could be seen in Figure 13.

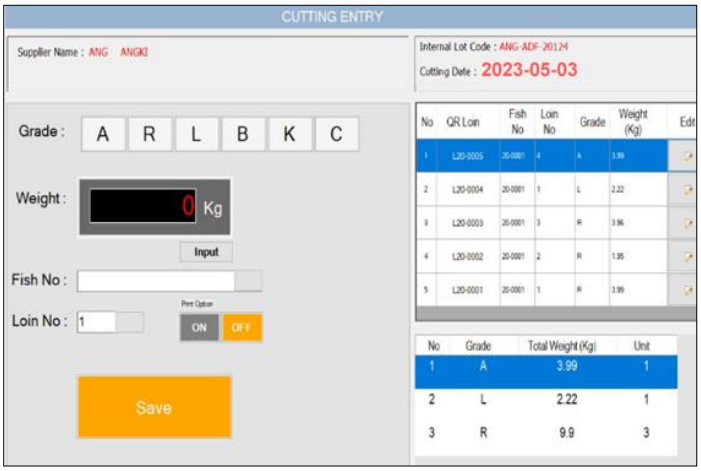

Figure 13 User Interface of Cutting Module

In cutting module, user entry weight and grade of each loin, and then system generates a QR Code label to be attached to each loin product. Each loin label consists of fish number information, vessel landing date, supplier name, batch code, vessel name, and fisherman name, vessel landing location, and landing location coordinates (latitude and longitude coordinate). Herewith sample of QR Code labels for loin products as seen in Figure 14

Figure 14 Example of QR Code Labels for Loin Products

The Packing Module is a module to save packing transaction, which loin products to put inside master carton boxes as packing activity. Each box will be attached label according to the loin product information in it. The packing module user interface display can be seen in Figure 15.

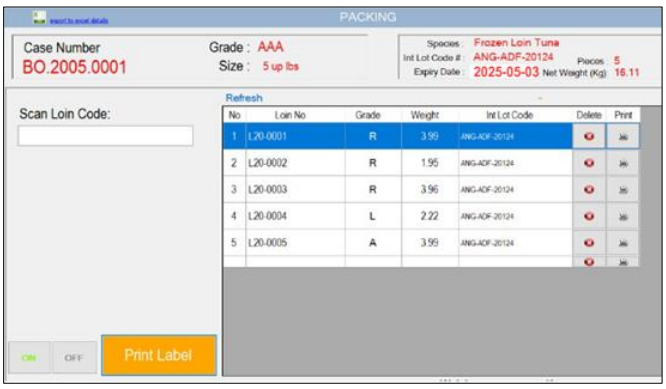

Figure 15 User Interface of Packing Module

This packing module generates box label, which contain information: box number, product grade, packing size, supplier, species, internal lot code, production date, expiration date, product number, product weight and vessel landing location. Information on the product label box displays information on the type of product, production date, landing location, supplier code, longitude and latitude coordinates of the fishing vessel landing location, so that this box label available to make it easier to trace fisheries products, the origin of the product based on the vessel landing location. Herewith sample of packing labels for loin products as seen in Figure 16.

Figure 16 Example of QR Code Label for Packing Products

4. Discussion

From the production result, each product in the form of Frozen Yellowfin Tuna Loin is packaged in vacuum plastic and labeled with QR Code. QR Code label help users to input product to packaging just by scan the label, and data recorded in the system automatically. This QR Code label contains product information in the form of grade and weight, and information on the origin of fish. Figure 17 shows the results of scanning the QR Code using the mobile camera or QR Code reader application.

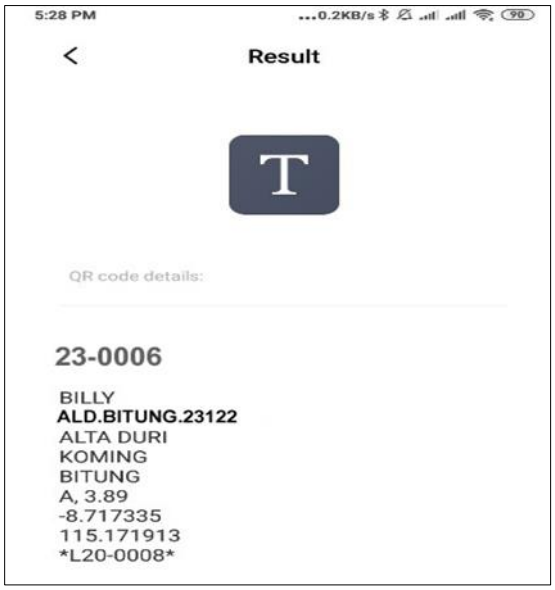

Figure 17 Example of Result Information Scanned by Mobile Phone

From catch module, system generates batch code consists of landing information by using format vessel code. Landing location, landing date with Julian date format. Julian calendar format make date code shortened as parts of batch code.

As seen in Figure 17, Julian code shows 122, it means landing date is 1 May. The batch code formulation could be seen in Table 4.

Table 4 Example Batch Code Formulation

Batch Code : ALD.BITUNG.23122		
Code	**Description**	**Details Description**
ALD	Vessel code	Vessel name: Alta Duri
BITUNG	Landing location	Bitung area
23	Year of landing	2023
122	Date of landing	Julian date: May, 1

QR Code symbol on the label used 100 pixels x 100 pixels dimension in size, which enable to store product information consists of 11 lines data. Based on result information displayed by mobile phone scanning, each of lines value based on Figure 17, could be explained in the Table 5.

Table 5 Information of Each Line from Result Displayed by Mobile Phone Scanning

Line	**Value**	**Description**
1'st	23-0006	Fish number sequence, generated automatic by system once receiving in company
2'nd	Blank value	N/A
3'rd	BILLY	Name of fisherman catch the fish
4'st	ALD.BITUNG.23122	Batch code: vessel code. Landing area. Landing date
5'st	ALTA DURI	Vessel name
6'st	KOMING	Supplier name
7'st	BITUNG	Landing area
8'st	A.3.89	Loin product result, with Grade A and product weight: 3.89 Kg
9'st	-8.717335	Latitude coordinates of landing location
10'st	115.171913	Longitude coordinates of landing location
11'st	*L20-0008*	Loin product code, each products has unique code

Based on Table 5, we could see the details of products information, and landing information, vessel and fisherman related to products origin. Small size of QR Code dimension (100 pixel x 100 pixel) enable to store many information in it. In this research, product labels used with a size of 10 cm x 5 cm printed by thermal transfer printing mode with full resin material label specifications. This research also examines QR Code label reading using the Honeywell QR Code scanner. The testing results of the QR Code label scanned are shown in Table 6.

Table 6 Testing Result of QR Code Label Reading

Label Condition	Label Position	Scanning distance	Can Be Read By Scanner?
Frozen and wet	Flat	25 cm	Yes
Frozen and wet	Flat	>25 cm	No
Frozen and wet	Curved	20 cm	Yes
Frozen and wet	Curved	>20 cm	No
Dry	Flat	40 cm	Yes
Dry	Flat	>40 cm	No
Dry	Curved	40 cm	Yes
Dry	Curved	>40 cm	No

Based on the test results from Table 6, it can be observed that the label condition in dry and flat and curved, the QR Code label could be read by the scanner at a maximum distance of 40 cm. So are the label condition in wet and frozen, the QR Code label still could be read by the scanner at a maximum distance of 25 cm under flat position. If the label is curved and frozen and rather wet, the label can be read by a scanner at a maximum distance of 20 cm. The system result shown in Figure 18, system could display maps of landing location of the vessel, once the product label scanned based on the landing site coordinate information (latitude and longitude coordinates).

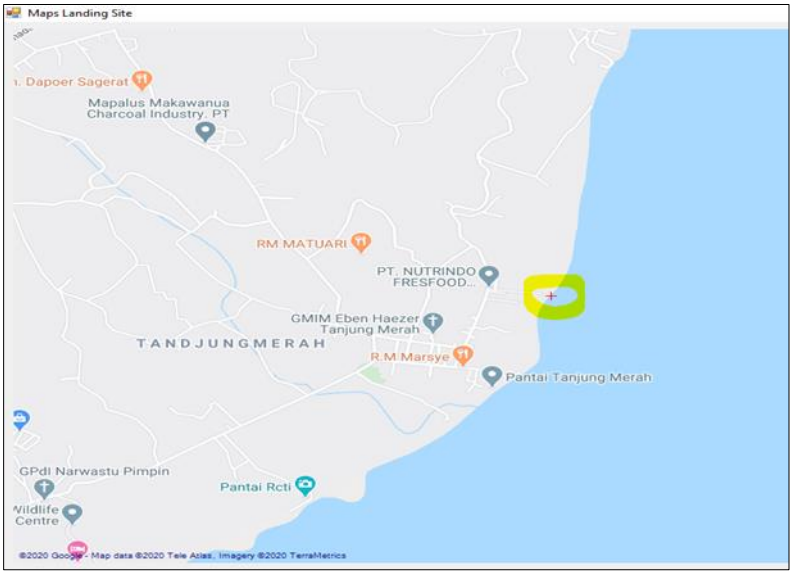

Figure 18 Example Maps User Interface of Landing Site Location

Based on Figure 18, seafood products can be traced from its origin by getting landing site location, so it could support food safety for consumers.

5. Conclusion

This research conduct batch code tagging enables to be traced from its origin while it represents landing information of fish and then each seafood product attached QR Code label which consists product information and landing information. The batch code moved along with the fish movement in each supply chain, from fisherman to supplier or processors. The product could be to be traced by scanning the QR Code labels and system shows product information, landing information, fishermen, suppliers, and a map of the landing site of origin of fish. The QR Code label has dimension 100 pixels x 100 pixels enable to store information in 11 lines of product information. The testing results of scanning QR Code label found that it can be scanned at maximum distance of 40 cm in the dry label condition in flat and curved position. While in condition wet label and freezing condition, the label can be scanned at a maximum distance of 25 cm

in flat conditions. Whereas if the label is in a curved position and wet and freezing conditions, the label can be scanned at a maximum distance of 20 cm. Once product label is scanned, the system can show the maps of the vessel landing location.

Compliance with ethical standards

Acknowledgments

Thanks to the seafood processor, PT Blue Ocean Grace International in Bitung North Sulawesi which has facilitate for this research.

Disclosure of conflict of interest

There are no conflicts of interest for the authors of this article

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