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# AQUARA: Development of an AI-Assisted Integrated Web and Mobile Digital Platform for Fisheries Information Services and Aquaculture Business Analysis

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**ABSTRACT**

Fish farmers in Indramayu Regency face difficulties in accessing fisheries information, evaluating aquaculture business feasibility, and communicating with the local fisheries authority because existing digital services are fragmented across multiple platforms. This study aims to develop AQUARA, an integrated web and mobile based platform that combines fisheries information, government services, aquaculture business analysis, discussion forums, a fish farmer directory, and AI assisted digital consultation. The platform was developed using a Research and Development (R&D) approach consisting of requirement analysis, system design, platform development, testing, and evaluation. System functionality was verified through Black Box Testing, non functional aspects were examined through performance, security, and compatibility testing, and usability was evaluated using the System Usability Scale (SUS). The testing results confirmed that all implemented features operated according to the specified requirements, the platform demonstrated acceptable response time, role based access control, and encrypted authentication, and it achieved a SUS score of 82.7 (Grade A), indicating excellent usability and high user acceptance. The integration of automated business feasibility analysis and the Dr. Fisho AI computer vision based preliminary fish disease detection feature within a single platform provides a practical solution for supporting the digital transformation of the aquaculture sector. The proposed platform improves information accessibility, supports business decision making, and strengthens collaboration among fish farmers and fisheries stakeholders.



## I. INTRODUCTION

Aquaculture plays a strategic role in supporting food security, improving community welfare, and contributing to national economic growth. Indonesia's aquaculture production reached 6.37 million tons in 2024, representing an increase of 13.64% compared to the previous year [1]. As aquaculture production continues to grow, the adoption of digital technologies has become increasingly important to improve information accessibility, operational efficiency, and sustainable fisheries management [2], [3].

Indramayu Regency is one of the major fisheries production centers in West Java Province. In 2024, the regency produced 523,265.16 tons of fisheries products, accounting for 32.70% of the province's total fisheries production, with aquaculture contributing 344,945.57 tons [4]. Despite its considerable production potential, several challenges remain in supporting aquaculture activities. Based on field observations and semi structured interviews conducted with the Department of Fisheries and Marine Affairs of Indramayu Regency (Diskanla) and 15 fish farmers, approximately 80% of respondents experienced difficulties in accessing accurate fisheries information, government assistance programs, and technical guidance. Furthermore, aquaculture business analysis, including capital estimation, operational cost calculation, and business feasibility assessment, is still performed manually, making the process time consuming and prone to calculation errors [5]. Communication and information exchange among fish farmers are also limited because no integrated platform currently facilitates collaboration among stakeholders [6], [7].

Several studies have proposed digital solutions for fisheries management. Ndoen et al. developed an information system for aquaculture farmer administration [8], while another study implemented a web based fisheries information system to support fisheries management [9]. Vistiyawati and Santoso developed a business intelligence dashboard to analyze aquaculture production trends [10]. Yuspita et al. investigated aquaculture business feasibility using financial analysis methods [11]. Meanwhile, IoT based solutions have also been proposed for automated fish feeding and aquaculture monitoring [12], [13]. Although these studies have demonstrated the benefits of digital technology in fisheries, most of them address specific functions independently, such as administrative management, production analysis, business evaluation, or aquaculture automation [14].

This limitation indicates that existing digital solutions remain fragmented and primarily focus on specific aspects of aquaculture, such as intelligent farming, decision support, sustainability monitoring, or business value chains, rather than providing a comprehensive digital ecosystem for fish farmers [15]. Existing studies rarely integrate fisheries information, government services, aquaculture business analysis, community discussion forums, and fish farmer directories into a unified platform [16]. Consequently, fish farmers often rely on multiple applications or manual processes to access information and manage aquaculture activities efficiently [17], [18].

The research gap addressed in this study can therefore be stated explicitly. Ndoen et al. [8] and Ihsan et al. [9] focused on administrative and management information systems without business analysis or community collaboration features; Vistiyawati and Santoso [10] provided a business intelligence dashboard limited to production visualization; Yuspita et al. [11] addressed business feasibility analysis in isolation using manual financial computation; Karyaningsih et al. (SIPATIN) [14] partially integrated information and community services but did not incorporate automated business analysis or AI based consultation; and IoT based studies [12], [13] concentrated on physical monitoring and automation rather than information and decision support services. None of these platforms combines fisheries information, government services, automated business feasibility analysis, discussion forums, a fish farmer directory, and AI assisted disease consultation within a single, centrally managed ecosystem. This gap between fragmented, single purpose digital fisheries tools and the need for a unified service platform constitutes the specific problem that AQUARA is designed to resolve, and it is further substantiated through the feature comparison presented in Table 4.

Therefore, this study proposes and develops AQUARA, an integrated web and mobile based digital platform for fisheries information and aquaculture business analysis. The platform integrates fisheries information services, government information, business analysis tools, discussion forums, and a fish farmer directory into a unified ecosystem [17]. The developed platform is expected to improve information accessibility, support more efficient aquaculture business management, facilitate collaboration among fish farmers and stakeholders, improve fisheries product market access [19] and contribute to the digital transformation of the aquaculture sector [16], [20].

Based on the identified problems, this study aims to (1) design and develop an integrated digital platform, AQUARA, that combines fisheries information, government information services, aquaculture business analysis, discussion forums, and a fish farmer directory within a single ecosystem; (2) provide an automated aquaculture business feasibility analysis tool to reduce the calculation errors commonly encountered in manual business assessment; and (3) evaluate the usability and practical applicability of the developed platform through user acceptance testing involving fish farmers and fisheries officers [20]. The main contribution of this study is twofold. First, from an engineering standpoint, AQUARA integrates six previously fragmented digital services, namely fisheries information, government information, automated aquaculture business analysis, discussion forums, a fish farmer directory, and AI assisted digital consultation, within a single layered architecture that keeps the web and mobile clients synchronized through a centralized RESTful API, distinguishing AQUARA from prior studies that addressed administrative management, production analysis, business evaluation, or automation independently. Second, from a scientific standpoint, this study contributes an empirically validated case of combining computer vision based preliminary disease diagnosis with human centered extension consultation and automated financial feasibility analysis in one platform, together with an evaluation that captures both functional correctness and user perceived usability, providing evidence that service integration of this scope is technically achievable without degrading usability.

## II. METHOD

This study employed a Research and Development (R&D) approach to design, develop, and evaluate the AQUARA digital platform. The R&D procedure adopted in this study refers to the model proposed by Sugiyono [22], which is a simplified adaptation of the classical Borg and Gall R&D model. This model was selected because it is oriented toward producing and validating a functional software product rather than a general educational intervention, and because its condensed sequence of stages is well suited to a single development cycle within the scope and timeframe of this study, while still retaining the essential need analysis, design, development, and evaluation stages required to produce a field tested product. The development process followed systematic software engineering practices, encompassing requirement analysis, system design, implementation, testing, and evaluation to ensure the quality and usability of the developed system [21], [22]. Accordingly, the research methodology consisted of five sequential phases: requirement

analysis, system design, platform development, system testing, and evaluation, as illustrated in Figure 1.

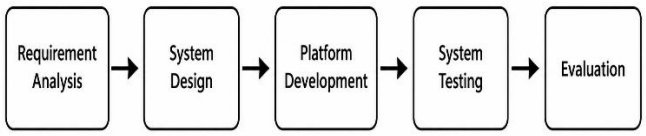


Figure 1. Research methodology of the AQUARA platform development

### A. *Requirement Analysis*

The requirement analysis phase aimed to identify user needs and existing challenges in aquaculture management. Data were collected through field observations and semi structured interviews with the Department of Fisheries and Marine Affairs of Indramayu Regency (Diskanla) and 15 fish farmers, selected using a purposive sampling technique based on their active involvement in aquaculture activities in Indramayu Regency. The collected information was analyzed to identify functional and nonfunctional system requirements.

The functional requirements included fisheries information management, government information services, aquaculture business analysis, discussion forums, and a fish farmer directory. Non functional requirements focused on usability, accessibility, security, and cross platform compatibility. The semi structured interview guide covered four themes, namely access to fisheries and government information, the process used to assess aquaculture business feasibility, communication with fisheries officers and fellow farmers, and prior experience with digital applications. Interview and observation notes from the 15 fish farmers and the Diskanla officers were transcribed and thematically grouped; recurring themes, such as difficulty locating assistance program information or reliance on manual spreadsheet based cost calculation, were then translated into concrete functional requirements, for example the government information module and the automated business analysis calculator described in Section II.C, so that each implemented feature can be traced back to a specific need expressed during this phase.

### B. *System Design*

Based on the identified requirements, the AQUARA platform was designed using the Object-Oriented Analysis and Design (OOAD) approach. Unified Modeling Language (UML), including use case, activity, sequence, and class diagrams, was used to model the system requirements and architecture.

The platform adopted a three-tier architecture consisting of the presentation, application, and database layers. The web application was developed using Laravel, while the mobile application was implemented using Flutter. Both applications communicated through RESTful APIs and utilized MySQL as the centralized database.

To make the internal structure and data flow of the platform explicit, Figure 2 presents the layered system architecture diagram and Figure 3 presents the data flow diagram of AQUARA. As shown in Figure 2, client requests originate from the Web Client (Laravel Blade views) or the Mobile Client (Flutter), and are transmitted over HTTPS as JSON payloads to a RESTful API Gateway. The API Gateway routes each request to the appropriate Controller, which delegates business rules, including the business feasibility Calculator Module and the Consultation Module, to the Service Layer. The Service Layer accesses persistent data exclusively through the Repository Pattern, which abstracts Eloquent ORM operations against the centralized MySQL database, so that presentation, business logic, and data access remain decoupled. For fish disease consultation, the Service Layer forwards the uploaded fish image to the Dr. Fisho AI computer vision module and returns the resulting preliminary diagnosis to the requesting client, while a parallel referral link connects the user to a fisheries extension officer through the WhatsApp channel.

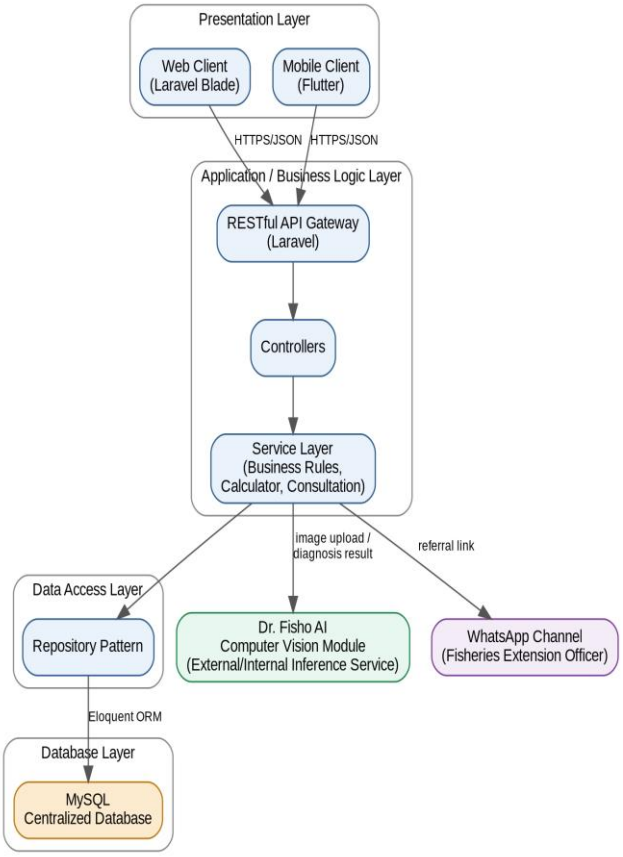


Figure 2. System Architecture Diagram of the AQUARA Platform

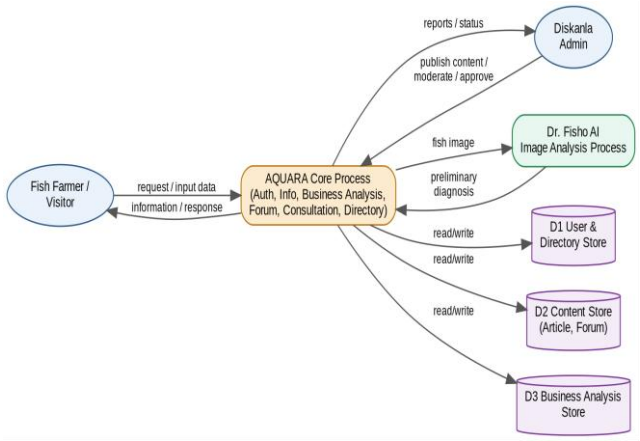


Figure 3. Data Flow Diagram (Level 0) of the AQUARA Platform

Figure 3 complements the architecture view by describing how data moves between external entities and internal data stores. Fish farmers and visitors submit requests, such as information searches, business analysis input, forum posts, or consultation images, to the AQUARA Core Process, which reads from and writes to three logical data stores, namely the user and directory store, the content store that holds articles and forum data, and the business analysis store that holds financial computation records. Diskanla administrators interact with the same core process to publish content, moderate discussions, and approve user registrations. Fish images submitted through the consultation feature are routed to the Dr. Fisho AI image analysis process, which returns a preliminary diagnosis to the core process for presentation to the user. This explicit separation between the core process and the AI process reflects the modular design described in Table 1 and clarifies how information consistency is maintained as data moves between the web client, mobile client, and centralized database.

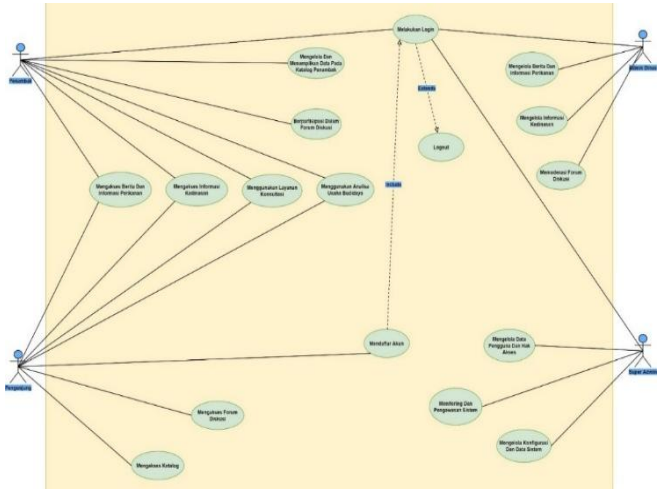

Figure. 4. Usecase Diagram

Figure 4 illustrates the use case diagram of the AQUARA platform. The system involves four actors: visitors, fish farmers, fisheries administrators, and super administrators. The platform provides several core services, including fisheries information, government information, aquaculture business analysis, discussion forums, consultation services, and fish farmer directory management.

### *C. Platform Development*

The AQUARA platform was developed following the approved system design. The implementation integrated several core modules, including fisheries information services, government information, aquaculture business analysis, discussion forums, and a fish farmer directory. The web application was implemented using the Laravel framework, while the mobile application was developed using Flutter. Both applications communicated with a centralized MySQL database through RESTful APIs, enabling synchronized data management across platforms.

The aquaculture business analysis module was developed to automatically evaluate business feasibility based on production and financial data entered by fish farmers. The system calculates three commonly used financial indicators, namely the Revenue Cost Ratio (R/C Ratio), Break Even Point (BEP), and Payback Period (PP). These indicators are computed automatically by the Calculator Module using the following equations.

$$\mathrm{R/C} = \frac{TR}{TC} \qquad (1)$$

where $TR$ is the total revenue and $TC$ is the total production cost.

$$\mathrm{BEP} = \frac{FC}{1 - \left(\frac{VC}{TR}\right)} \qquad (2)$$

where $FC$ denotes the fixed cost and $VC$ represents the variable cost.

$$\mathrm{PP} = \frac{I}{NP} \qquad (3)$$

where $I$ is the total initial investment and $NP$ is the annual net profit.

The calculated values are processed automatically after the required financial data have been submitted by the user. An R/C Ratio greater than 1 indicates that the aquaculture business is financially feasible, while the BEP and PP provide information regarding the minimum revenue required to cover production costs and the estimated investment recovery period, respectively. The implementation of these equations enables the system to perform consistent and accurate business feasibility analysis without requiring manual calculations.

The parameters used in the business feasibility module, namely the Revenue Cost Ratio, Break Even Point, and Payback Period, were selected because they are the three indicators most commonly required by Diskanla and microfinance institutions when assessing small scale

aquaculture proposals in Indramayu Regency, and because they can be computed directly from the capital, production, and operational cost data that fish farmers already record. To validate the Calculator Module, the automated outputs for a set of sample cases were cross checked against manual spreadsheet based calculations prepared by the research team; the automated and manual results matched exactly, confirming that Equations (1) to (3) were implemented correctly in the system.

### *D. AI Based Digital Consultation (Dr. Fisho AI)*

The Digital Consultation feature combines an artificial intelligence component with a human consultation channel. Dr. Fisho AI performs preliminary fish disease identification using an image classification approach: the user captures or uploads a photograph of the affected fish, the image is preprocessed (resized and normalized) and passed to a convolutional neural network based classifier, and the model returns the most probable disease category together with a short description of typical symptoms and recommended initial actions. The classifier's knowledge base is limited to a predefined set of common fish diseases relevant to the freshwater and brackish water species cultivated in Indramayu Regency; conditions outside this set, or images of insufficient quality, are flagged as inconclusive rather than being forced into a diagnosis.

Dr. Fisho AI is built on a Convolutional Neural Network (CNN) trained to classify images of diseased fish into the predefined disease categories described above. The model was trained and validated using a dataset of 500 labeled fish images collected to represent the common disease conditions encountered in freshwater and brackish water aquaculture in Indramayu Regency. On the held out test data, the model achieved an overall classification accuracy of 85%, which was considered acceptable for a preliminary screening tool given that every result is subsequently reviewed by a fisheries extension officer rather than acted upon directly by the user. The model was trained to distinguish 12 common fish disease classes relevant to the species cultivated in Indramayu Regency. The 500 image dataset was divided using a 70/15/15 split, allocating 70% of the images for training, 15% for validation during model tuning, and the remaining 15% as a held out test set used to report the 85% accuracy figure above. Model development and training were carried out using TensorFlow and PyTorch.

The recommendation is not presented to the user as a final diagnosis. Every AI generated result is labeled as a preliminary indication and is paired with a direct WhatsApp referral to a fisheries extension officer at Diskanla, who reviews the case and provides an authoritative recommendation; this two step design, an automated screening stage followed by mandatory human validation, is intended to reduce the risk of farmers acting on an incorrect automated diagnosis alone and keeps the extension officer accountable for the final treatment advice.

### *E. Information Quality and Content Governance*

To keep the information published on AQUARA accurate, current, and consistent with official policy, content on the Fisheries Information and Government Information modules is not published directly by end users. Articles, announcements, and assistance program information are drafted or supplied by Diskanla staff through the Admin Module, reviewed by an authorized Diskanla administrator before being made publicly visible, and can be edited or withdrawn if the underlying policy changes, so that the platform functions as an extension of Diskanla's official communication channels rather than an open, unmoderated content source. Discussion forum posts, in contrast, are user generated and are moderated after publication, with the Admin Module allowing administrators to remove or flag inappropriate or misleading posts, as reflected in the administrative test scenarios in Table 2.

### *F. Data Security and Privacy*

Because AQUARA stores personal data such as user names, contact details, and farm location, several safeguards were implemented at the application level. User authentication relies on hashed and salted password storage rather than plaintext credentials, session based authentication tokens are used to authorize subsequent API requests, and role based access control restricts each of the four actor types (visitor, fish farmer, Diskanla administrator, and super administrator) to the modules and data relevant to that role, consistent with the User Management Module described in Table 1. All communication between the web and mobile clients and the RESTful API is transmitted over HTTPS to protect data in transit. In addition, server side input validation is applied to incoming requests to prevent malformed or malicious data from reaching the business logic and database layers, complementing the authentication, hashing, and role based access safeguards described above.

### *G. System Testing*

System testing was conducted to verify that all implemented functionalities operated according to the specified requirements. Functional testing employed the Black Box Testing method by evaluating each feature using predefined test scenarios covering both valid and invalid input conditions. The testing process verified user authentication, information management, business analysis, discussion forums, directory management, and administrative functions, with 15 test scenarios executed in total.

### *H. Non Functional Testing*

In addition to functional verification, non functional aspects of the platform, namely performance, security, and cross platform compatibility, were examined to address requirements identified in Section II.A. Performance testing measured API response time under typical single user load for representative endpoints (login, information listing, and business analysis calculation). Security testing covered authentication safeguards, namely resistance to invalid login

attempts, session handling, and role based access restriction, corresponding to the safeguards described in Section II.C.6. Compatibility testing verified that the web application rendered correctly on the latest versions of Chrome, Firefox, and Edge, and that the Flutter mobile application functioned correctly on representative Android OS versions.

The non functional testing demonstrated satisfactory system performance, with API response times remaining below one second under normal conditions for the tested endpoints. The platform also operated successfully across the major web browsers tested, namely Google Chrome, Microsoft Edge, and Mozilla Firefox, as well as on Android smartphones, without significant functional or interface issues, confirming acceptable cross platform compatibility. Detailed results are presented in Section III.C.

### *I. Evaluation*

The developed platform was evaluated to assess its usability and practical applicability using the System Usability Scale (SUS). The evaluation involved representative users, including fish farmers and fisheries officers, who interacted with the AQUARA platform and subsequently completed the SUS questionnaire consisting of ten standardized statements measured using a five point Likert scale ranging from *Strongly Disagree (1)* to *Strongly Agree (5)*. The SUS instrument was selected because it is widely used to evaluate software usability and provides a reliable overall usability score.

The SUS score was calculated according to the standard procedure. For odd numbered items, the contribution score was obtained by subtracting one from the respondent's score, whereas for even numbered items, the contribution score was obtained by subtracting the respondent's score from five. The sum of all contribution scores was then multiplied by 2.5 to obtain the final SUS score ranging from 0 to 100.

$$SUS = \left( \sum_{i=1}^{10} S_i \right) \times 2.5 \qquad (4)$$

where $S_i$ represents the adjusted contribution score of each questionnaire item. A higher SUS score indicates better system usability, while scores above 68 generally indicate acceptable usability performance.

## III. RESULT AND DISCUSSION

### *A. Implementation*

The AQUARA platform was implemented as a web application using the Laravel framework and a mobile application using Flutter, both connected to a centralized MySQL database through RESTful APIs. The implementation covers five core modules identified during the requirement analysis phase: fisheries information, government information, aquaculture business analysis, discussion forums, and fish farmer directory, in addition to an administrative module for content and user management.

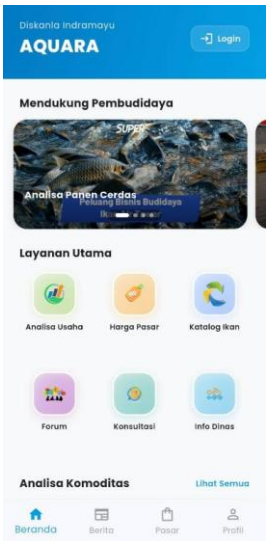


Figure 5. AQUARA Dashboard Interface

On the fisheries and government information pages, users can browse and search published articles, announcements, and assistance program information. The business analysis module allows fish farmers to input capital investment, production, and operational cost data and automatically generates business feasibility indicators, including the Revenue–Cost (R/C) Ratio, Break Even Point (BEP), and Payback Period (PP). The calculations are performed automatically based on the financial model described in Equations (1)–(3), and the resulting values are presented instantly to support business decision-making.

The discussion forum enables fish farmers, fisheries officers, and other stakeholders to exchange information and discuss aquaculture-related issues, while the fish farmer directory provides a searchable list of registered farmers based on location and commodity type. In addition, the platform integrates Dr. Fisho AI, which performs preliminary fish disease detection using computer vision and provides an initial diagnosis that can be followed by consultation with fisheries extension officers through the platform.


Figure 6. Aquaculture Business Analysis Interface

In addition to the dashboard, AQUARA provides dedicated Fisheries Information and Government Information features. The Fisheries Information module presents an encyclopedia of cultivated fish commodities, covering characteristics, cultivation potential, and a stock exchange menu (Bursa Stok) that helps fish farmers monitor the availability of harvested commodities and expand their market access. The Government Information module serves as an official channel for the Indramayu Regency Department of Fisheries and Marine Affairs (Diskanla) to publish news, government assistance programs, and departmental activities, together with quick access links to the official Diskanla and West Java provincial government websites.

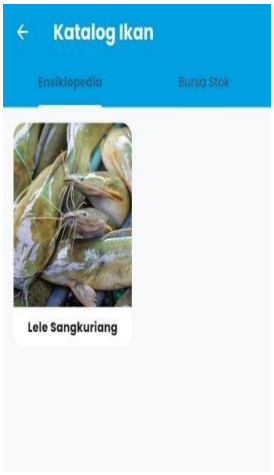


Figure 7. Fisheries Information Interface


Figure 8. Government Information Interface

By centralizing these two information services within a single platform, fish farmers no longer need to search across multiple media channels to obtain accurate and up to date information regarding cultivation techniques, market prices, and government programs, directly addressing the information fragmentation problem identified during the requirement analysis phase.

The Discussion Forum feature functions as a collaboration space where fish farmers, fisheries officers, academics, and the general public can exchange information and share field experiences related to aquaculture practices. Users can create discussion posts, comment on existing posts, and interact with other members of the community, supporting collective learning and strengthening the network among stakeholders.


Figure 9. Discussion Forum Interface

The Digital Consultation feature integrates artificial intelligence with direct consultation services to help fish farmers obtain solutions more quickly. Its main component, Dr. Fisho AI, applies computer vision to provide an initial identification of fish disease based on image analysis: the user captures or uploads a photo of the fish, and the system analyzes visual characteristics to generate a preliminary diagnosis before the farmer proceeds to further consultation with a fisheries extension officer. This feature is

complemented by a direct WhatsApp channel to fisheries extension officers and a link to the official Diskanla Instagram account for the latest programs and educational content. The integration of computer vision based disease detection with human consultation channels distinguishes AQUARA from the fisheries information systems reviewed in the introduction, none of which combine automated visual diagnosis with government consultation services in a single platform.


Figure 10. Digital Consultation Interface (Dr. Fisho AI)

The Fish Farmer Catalog serves as a digital promotion medium that allows fish farmers to display their cultivation business profile, including commodity type, location, and price, so that they can expand their marketing network and increase collaboration opportunities among fellow business actors. Combined with the discussion forum, this feature completes the collaborative dimension of AQUARA that was previously unavailable in a centralized form.

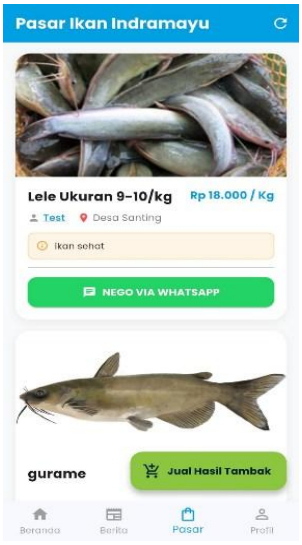


Figure 11. Fish Farmer Catalog Interface

## B. System Architecture

AQUARA was implemented using a Model View Controller (MVC) architecture combined with a Layered Architecture approach, dividing the system into a Presentation Layer, Business Logic Layer, Data Access Layer, and Database Layer. A Repository Pattern was applied to separate the data access mechanism from the business logic, while a Service Layer was introduced to handle more complex business processes such as the aquaculture business analysis calculations. This layered approach improves the modularity, testability, and maintainability of the codebase and facilitates the development of additional features in future iterations. This implemented structure corresponds directly to the layered architecture and data flow illustrated earlier in Figure 2 and Figure 3, confirming that the deployed system follows the architecture defined during the design phase rather than diverging from it during implementation.

TABEL 1
DESCRIPTION OF AQUARA SYSTEM COMPONENTS

| Component | Description |
|---|---|
| Authentication Module | Manages user authentication, including login, logout, and account registration. |
| User Management Module | Manages user data, profiles, and role based access control (Visitor, Fish Farmer, Diskanla Admin, Super Admin). |
| Article Module | Manages articles, news, and fisheries information displayed on the platform. |
| Forum Module | Manages discussion forums, topics, and comments among users. |
| Calculator Module | Manages the aquaculture business analysis feature and cultivation cost calculator. |
| Consultation Module | Manages consultation services, including the AI based disease detection (Dr. Fisho AI) and WhatsApp integration with fisheries officers. |
| Admin Module | Manages the administration panel, including content management, forum moderation, and system configuration. |

As shown in Table 1, the seven core components work together to support the complete business process of the platform, from user management and information delivery to business analysis, consultation, and system administration, confirming that the implemented system corresponds to the architecture defined during the design phase.

## C. Testing

System testing was performed on the AQUARA platform using the Black Box Testing method to verify that each implemented feature functioned according to the specified functional requirements. A total of 15 test scenarios were designed and executed, covering user authentication, information management, business analysis, discussion forums, directory management, and administrative functions, with two to three scenarios examined for each module under both valid and invalid input conditions.

TABEL 2
BLACK BOX TESTING

| No | Module | Test Scenario | Expected Result | Actual Result |
|---|---|---|---|---|
| 1 | Authentication | Login with valid credentials | User successfully logs in and is redirected to the dashboard. | Valid |
| 2 | Authentication | Login with invalid password | System rejects the login attempt and displays an error message. | Valid (rejected as expected) |
| 3 | Authentication | Register new user account with valid data | New account is created and the user can log in. | Valid |
| 4 | Information Management | View fisheries information list | List of published articles and information is displayed correctly. | Valid |
| 5 | Information Management | Search information using an invalid/no match keyword | System displays a no result message. | Valid (no result, as expected) |
| 6 | Information Management | View government/assistance program detail | Program detail page is displayed correctly. | Valid |
| 7 | Business Analysis | Input valid capital and operational cost data | Data is accepted and stored for feasibility calculation. | Valid |
| 8 | Business Analysis | Calculate R/C Ratio, BEP, and Payback Period from input data | System displays the correct R/C Ratio, BEP, and PP values. | Valid |
| 9 | Business Analysis | Input negative/invalid cost value | System rejects the input and displays a validation error. | Valid (rejected as expected) |
| 10 | Discussion Forum | Create a new discussion post | Post is published and visible to other users. | Valid |
| 11 | Discussion Forum | Submit an empty comment | System rejects the empty submission. | Valid (rejected as expected) |
| 12 | Directory Management | Search fish farmer by location/region | Matching farmer records are displayed. | Valid |
| 13 | Directory Management | Search with no matching result | System displays a no result message. | Valid (no result, as expected) |
| 14 | Administrative Functions | Approve new user registration (admin) | User account status is updated to approved. | Valid |
| 15 | Administrative Functions | Moderate/delete inappropriate discussion post (admin) | Post is removed from the forum. | Valid |

As shown in Table 2, all functional test scenarios were successfully completed. In addition to functional testing, non-functional testing confirmed satisfactory platform performance, security, and cross-platform compatibility. Representative API endpoints responded in less than one second under normal operating conditions, invalid login attempts and unauthorized role access were successfully rejected, and the platform operated correctly on Google Chrome, Mozilla Firefox, Microsoft Edge, and Android devices. These results indicate that AQUARA satisfies the specified non-functional requirements and complements the functional correctness demonstrated by the Black Box Testing results.

### *D. Usability Evaluation*

The usability of the AQUARA platform was evaluated using the System Usability Scale (SUS) involving 15 representative users, consisting of the same 15 fish farmers engaged during the requirement analysis phase together with fisheries officers from Diskanla, so that the evaluators reflected the platform's intended end users. Respondents ranged in age from young to senior fish farmers with varying levels of prior smartphone and application usage experience, which was intentionally preserved to capture usability across differing levels of digital literacy rather than being restricted to technically proficient users. The evaluation procedure was conducted in a single session per respondent: each participant first received a brief orientation to the purpose of the study, then completed a guided walkthrough of the platform's core features (fisheries information, government information, business analysis, discussion forum, digital consultation, and farmer directory) on their own device or a provided device, and immediately afterward completed the ten standardized SUS statements using a five point Likert scale under the direct supervision of the research team, who were available to clarify any statement that respondents found ambiguous. The collected responses were processed according to the standard SUS scoring procedure to obtain the overall usability score.

The evaluation results showed that the AQUARA platform achieved an average SUS score of 82.7, indicating that the developed system provides a high level of usability. According to the SUS interpretation guidelines, this score falls within the Grade A category and is classified as Excellent, indicating that users considered the platform easy to learn, easy to use, and suitable for supporting fisheries information management and aquaculture business analysis.

TABEL 3
SYSTEM USABILITY SCALE (SUS) EVALUATION RESULTS

| Evaluation | Result |
|---|---|
| Number of Respondents | 15 |
| SUS Score | **82.7** |
| Grade | A |
| Acceptability | Acceptable |
| Adjective Rating | Excellent |

The obtained SUS score indicates that the AQUARA platform provides excellent usability and effectively supports fisheries information management, aquaculture business analysis, and communication among stakeholders. The high usability score demonstrates that integrating fisheries information, government services, business analysis, discussion forums, digital consultation, and the fish farmer directory into a single platform does not reduce usability. Instead, users perceived the integrated design as intuitive and beneficial for supporting their daily aquaculture activities.

Beyond usability, several SUS items and open feedback collected during the evaluation session provide preliminary indications of operational benefit. Respondents who previously performed business feasibility calculations manually reported that the automated Calculator Module removed a step that had been prone to arithmetic error and normally required consulting a separate worksheet, suggesting a reduction in the effort needed to reach a feasibility decision. Similarly, respondents who previously relied on visiting the Diskanla office or searching multiple social media channels for assistance program announcements indicated that locating the same information within AQUARA required fewer steps.

### *E. Discussion*

Table 4 summarizes how AQUARA compares with the digital fisheries solutions reviewed in the introduction, highlighting the level of integration achieved by the proposed platform.

TABEL 4
FEATURE COMPARISON BETWEEN AQUARA AND RELATED DIGITAL FISHERIES SOLUTIONS

| Study | Info. & Gov't Services | Business Analysis | Forum & Directory |
|---|---|---|---|
| Ndoen et al. [8] | Partial | No | No |
| Vistiyawati & Santoso [10] | Partial | No | No |
| Yuspita et al. [11] | No | Yes | No |
| Karyaningsih et al. (SIPATIN) [14] | Partial | No | Partial |
| AQUARA (this study) | Yes | Yes | Yes |

Another distinguishing feature of AQUARA is the integration of Dr. Fisho AI, a computer vision based preliminary fish disease detection module. Unlike previous systems that primarily relied on IoT devices for environmental monitoring, this feature enables users to obtain an initial diagnosis directly from fish images and continue the consultation process through fisheries extension officers. Consequently, the platform not only supports information management but also facilitates faster decision making for disease handling and aquaculture management.

The comparison summarized in Table 4 was constructed by reviewing the features reported in the published description of each related system [8], [10], [11], [14] and classifying each service dimension as fully supported (Yes), partially supported (Partial), or absent (No); a dimension was marked Partial when the related study implemented only part of the corresponding AQUARA module, for example information display without an interactive assistance program request feature. This criterion based comparison, rather than a purely narrative description, is intended to make the evaluation of AQUARA's advantages over existing solutions more objective and independently verifiable, although the comparison is necessarily limited to the functionality documented in each source publication and could not include performance or usability benchmarking of the compared systems, since the corresponding platforms were not available for direct testing by the research team.

The functional testing results confirmed that all implemented modules operated according to the specified requirements, demonstrating that the proposed platform successfully implemented the designed functionalities without functional errors. These findings indicate that the integration of multiple services within a single application can be achieved without compromising system functionality.

Furthermore, the usability evaluation using the System Usability Scale (SUS) produced an average score of 82.7, corresponding to Grade A with an Excellent adjective rating. This result indicates that representative users perceived the platform as easy to learn, easy to operate, and appropriate for supporting fisheries information management and aquaculture business analysis. The high SUS score also suggests that integrating multiple functional modules into a single platform did not increase interaction complexity. Instead, users considered the unified design beneficial because it reduced the need to switch between different applications during daily aquaculture activities.

From a software engineering perspective, the layered MVC architecture combined with the Repository and Service Layer patterns contributes to the maintainability and scalability of the platform. Separating presentation, business logic, and data access enables each functional module to be developed and maintained independently, facilitating future system enhancement. In addition, the implementation of RESTful APIs allows the Laravel based web application and Flutter mobile application to share a centralized database while maintaining consistent and synchronized information across platforms.

The findings of this study also have practical implications for the digital transformation of aquaculture services in Indramayu Regency. By integrating fisheries information, business feasibility analysis, digital consultation, and government information into a single platform, AQUARA

can improve information accessibility, support business decision making, and strengthen communication between fish farmers and fisheries officers. This integrated approach aligns with the concept of smart aquaculture by utilizing software based digital technologies that remain affordable and accessible for small scale fish farmers.

Although AQUARA was designed and evaluated for Indramayu Regency, its layered architecture and modular services are not tied to region specific business logic, which suggests the platform could in principle be adapted to other aquaculture producing regencies in West Java or elsewhere in Indonesia by replacing region specific content, namely local fisheries information, government assistance programs, and the extension officer contact channel, while reusing the authentication, business analysis, forum, and consultation modules described in Table 1. Realizing this potential at a larger scale, however, would raise several practical challenges that were not addressed within the current scope: each adopting regency would need its own content governance workflow similar to the one described in Section II.C.7, since fisheries information and assistance programs vary by local government; the Dr. Fisho AI module would need to be retrained or extended to cover disease patterns and fish species relevant to the target region if these differ from those cultivated in Indramayu; and the underlying infrastructure would need to accommodate a larger and more geographically distributed user base than the 15 respondents evaluated in this study, which has direct implications for the server capacity, database scalability, and network reliability required for a multi region deployment.

Despite these encouraging results, this study has several limitations that should be considered when interpreting its findings. First, regarding implementation scope, the current version of AQUARA was deployed and evaluated as a functional prototype covering the five core modules described in Section III.A; it has not yet undergone a full production rollout with live monitoring under real world operating conditions, such as sustained multi user concurrent access or extended uptime measurement. Second, the trial and evaluation activities, including the requirement analysis interviews and the usability evaluation, were confined to fish farmers and Diskanla officers within Indramayu Regency; consequently, the findings may not generalize to fish farmers in other regencies with different levels of digital literacy, infrastructure availability, or fish species cultivated, which is directly relevant to the broader implementation discussed above. Third, the Dr. Fisho AI feature has its own specific limitations: its disease classification is restricted to a predefined set of common diseases relevant to the species cultivated in Indramayu Regency, although it achieved 85% classification accuracy on the 500 image test dataset described in Section II.C.5, this evaluation has not yet been cross validated against independent veterinary or fisheries expert diagnosis on a separate field collected sample, and it is intended only as a preliminary screening aid that must be followed by human consultation rather than as a stand alone diagnostic tool. Fourth, the usability evaluation involved only 15 representative respondents, which may not fully represent the diversity of fish farmers in Indramayu Regency, and it assessed usability and short term interaction rather than long term adoption or performance under larger scale deployment. Finally, this study did not include an extended field trial in which the platform was used unsupervised by fish farmers over a defined period of weeks or months; the reported evidence of benefit is therefore based on a single supervised evaluation session rather than sustained real world use, and claims about long term impact on productivity or decision quality should be read as preliminary indications rather than confirmed outcomes. Addressing these limitations, future research should involve a larger and more diverse group of respondents across multiple regencies, evaluate API performance, scalability, and security under production level conditions, quantitatively validate the Dr. Fisho AI classifier against expert diagnosis, and conduct a longitudinal field trial to measure the platform's sustained impact on aquaculture productivity and digital service adoption.

## IV. CONCLUSION

This study developed AQUARA, an integrated web and mobile based digital platform that combines fisheries information, government information, aquaculture business analysis, discussion forums, a fish farmer directory, and AI assisted digital consultation to support fish farmers in Indramayu Regency, implemented using a layered Model View Controller architecture whose structure and data flow were made explicit through the system architecture and data flow diagrams presented in Section II.B. Black Box Testing confirmed that all implemented functionalities operated according to the specified requirements, non functional testing indicated acceptable response time, compatibility, and role based security safeguards, and the usability evaluation using the System Usability Scale (SUS) produced an average score of 82.7, corresponding to Grade A (Excellent), indicating that the platform is easy to use and well accepted by representative users. These findings demonstrate that AQUARA successfully achieved the research objectives of integrating previously fragmented fisheries services into a single platform while providing automated business feasibility analysis and AI assisted preliminary fish disease detection, distinguishing it from the fragmented digital fisheries solutions identified in the research gap. At the same time, the findings are bounded by the limitations discussed in Section III.E, namely a single regency setting, a prototype level rather than production level deployment, an AI classifier whose 85% test accuracy has not yet been cross validated against independent expert diagnosis, and the absence of a longitudinal field trial. Future research should therefore involve a larger and more diverse group of respondents across multiple regencies, quantitatively evaluate system performance, scalability, and data security under production conditions, cross validate the Dr. Fisho AI classifier's accuracy against independent expert diagnosis, and conduct

an extended field trial to confirm the platform's real world impact on aquaculture productivity, decision making, and digital service adoption before wider implementation in other aquaculture regions.

## REFERENCES


[1] Kementerian Kelautan dan Perikanan Republik Indonesia (KKP), "Menteri Trenggono Berhasil Tingkatkan Produksi Perikanan Budi Daya 13,6% di 2024." Accessed: Jul. 20, 2026. [Online]. Available: https://kkp.go.id/news/news-detail/menteri-trenggono-berhasil-tingkatkan-produksi-perikanan-budi-daya-136-di-2024-vQq0.html

[2] H. Zhang and F. Gui, "The Application and Research of New Digital Technology in Marine Aquaculture," Feb. 01, 2023, MDPI. doi: 10.3390/jmse11020401.

[3] N. Saleh, M. Alwi, S. Bahri, A. Gunawan, and R. Chakti, "Advances in Consumer Research Digital Transformation in the Agriculture and Fisheries Sector for Sustainable Economic Development," 2025. [Online]. Available: https://acr-journal.com/

[4] Direktorat Jenderal Informasi dan Komunikasi Publik, "Sumbang 32,70 persen, Indramayu Tegaskan Posisi sebagai Lumbung Perikanan Jawa Barat," infopublik.id. Accessed: Jul. 20, 2026. [Online]. Available: https://infopublik.id/kategori/nusantara/906297/index.html

[5] S. Kruk, S. Kloppenburg, and F. Lovita, "Digital platforms governing practices: how data objects reconfigure Indonesian fish farming," J. Rural Stud., vol. 119, p. 103764, Oct. 2025, doi: 10.1016/j.jrurstud.2025.103764.

[6] B. Lahiri et al., "Determinants of Digitised Farm Information Outreach in Aquaculture: A Case of Mobile Phone Application for Smallholder Fish Farmers in North East India," Journal of the Knowledge Economy, vol. 16, pp. 15342–15380, Dec. 2024, doi: 10.1007/s13132-024-02471-1.

[7] W. Niangti et al., "Training Needs of Fish Farmers for the Development of Fisheries and Aquaculture in Meghalaya," Indian Journal of Extension Education, vol. 61, no. 2, pp. 45–50, Apr. 2025, doi: 10.48165/IJEE.2025.61209.

[8] F. S. Ndoen, M. Boru, and C. E. A. Pah, "Implementasi Sistem Informasi Data Pelaku Usaha Perikanan Budidaya Pada Dinas Perikanan Kota Kupang," Rabit : Jurnal Teknologi dan Sistem Informasi Univrab, vol. 8, no. 2, pp. 184–194, Jul. 2023, doi: 10.36341/rabit.v8i2.3475.

[9] H. Ihsan, E. Yandani, and R. Efendi, "Transformasi Digital dalam Budidaya Perikanan: Sistem Informasi Manajemen Perikanan," Journal of Vocational Education and Information Technology, vol. 5, no. 2, pp. 62–75, 2024.

[10] V. Vistiyawati and C. Budy Santoso, "Implementasi Business Intelligence untuk Prediksi Produksi Perikanan Budidaya Berbasis Web Dashboard Visualisasi," Jurnal Algoritma, vol. 22, no. 2, Nov. 2025, doi: 10.33364/algoritma/v.22-2.2902.

[11] N. Luh Eta Yuspita and N. Anggi Felisha, "Analisis Kelayakan Usaha Budidaya Ikan Kerapu Sistem Keramba Jaring Apung Di Teluk Pegametan, Bali," Jurnal Agri Sains, vol. 9, no. 1, 2025, [Online]. Available: http://ojs.umb-bungo.ac.id/index.php/JAS/index

[12] E. M. Indrawati, B. Suprianto, and U. T. Kartika, "Pemberi Pakan Ikan Otomatis berbasis IoT dengan FLC Berdasarkan Kualitas Air (Suhu, PH, Kekeruhan)," JST (Jurnal Sains dan Teknologi), vol. 13, no. 3, pp. 383–394, Oct. 2024, doi: 10.23887/jstundiksha.v13i3.85982.

[13] A. Subowo and N. Pradita, "Design of an IoT-Based Aquaculture Monitoring System Based on IoT in Fish Farming," ENERGY: JURNAL ILMIAH ILMU-ILMU TEKNIK, vol. 15, no. 2, pp. 152–164, Oct. 2025, doi: 10.51747/energy.v15i2.15203.

[14] D. Karyaningsih et al., "Integrated System-Based Smart Application (SIPATIN) For Strengthening Fisheries Governance In Lebak Regency, Banten," JITK (Jurnal Ilmu Pengetahuan dan Teknologi Komputer), vol. 11, no. 2, pp. 391–401, Nov. 2025, doi: 10.33480/jitk.v11i2.7124.

[15] A. Gangnery, C. Bacher, A. Boyd, H. Liu, J. You, and Ø. Strand, "Web-based public decision support tool for integrated planning and management in aquaculture," Ocean Coast. Manag., vol. 203, p. 105447, 2021, doi: https://doi.org/10.1016/j.ocecoaman.2020.105447.

[16] C. Wang, Z. Li, T. Wang, X. Xu, X. Zhang, and D. Li, "Intelligent fish farm—the future of aquaculture," Aquaculture International, vol. 29, no. 6, pp. 2681–2711, 2021, doi: 10.1007/s10499-021-00773-8.

[17] U. F. Mustapha, A.-W. Alhassan, D.-N. Jiang, and G.-L. Li, "Sustainable aquaculture development: a review on the roles of cloud computing, internet of things and artificial intelligence (CIA)," Rev. Aquac., vol. 13, no. 4, pp. 2076–2091, Sep. 2021, doi: https://doi.org/10.1111/raq.12559.

[18] A. M. Kaminski et al., "A review of inclusive business models and their application in aquaculture development," Rev. Aquac., vol. 12, no. 3, pp. 1881–1902, Aug. 2020, doi: https://doi.org/10.1111/raq.12415.

[19] M. Sukma, F. Firman, G. Septiyanti, N. Zirani, and S. Putri, "Pemanfaatan Teknologi Informasi dan Komunikasi untuk Meningkatkan Akses Pasar Produk Perikanan," Mimbar Administrasi Fisip Untag Semarang, vol. 22, pp. 266–282, Jun. 2025, doi: 10.56444/mia.v22i1.2953.

[20] P. J. I. Chandran, S. Khalil, H. PK, and S. Veerasingam, "Smart Technologies in Aquaculture: An Integrated IoT, AI, and Blockchain Framework for Sustainable Growth," Aquac. Eng., vol. 111, p. 102584, Jun. 2025, doi: 10.1016/j.aquaeng.2025.102584.

[21] R. S. Pressman and B. R. Maxim, Software Engineering: A Practitioner's Approach (9th ed.), McGraw-Hill. 2020.

[22] Sugiyono, Metode Penelitian dan Pengembangan (Research and Development/R&D). Bandung: Alfabeta, 2022.