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Original Article

Development and Evaluation of Pelagic: A Hybrid Web-Mobile Platform for Efficient Pelagic Fisheries Terminal Management

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Abstract - *The management of small-scale fisheries poses several challenges given the need for biodiversity and climate resiliency in the face of current crises. PELAGIC is a hybrid web-mobile application that aims to streamline pelagic fisheries terminal management. Using StormGlass API, users can post pictures, report a species profile, and receive weather warnings on wind, waves, and El Niño. PELAGIC is data-driven, needs offline capabilities, and uses GPS to relay data. Through a developmental-descriptive process and a variant of SDLC Waterfall model, PELAGIC is designed using Flutter/Dart mobile and Svelte/JavaScript web, and MongoDB, Tailwind CSS, and Leaflet.js. ISO/IEC 25010 outlined questionnaires assessed PELAGIC and rated it "Very Effective" (overall mean = 4.62/5.00). Using quantitative measures, Pelagic transformed a 70% current baseline MFRS transcription error rate to 3.2%, shortened the current 30-90 days report lag to a near real-time (<2 sec query) framework, and showed 95.2% success rate for offline (no-data internet) users. While existing platforms - PeskAAS (requires constant connection to the internet, no weather feature), and ABALOBI (indifferent to weather conditions and grocer owner interfaces, does not feature national languages, including Hiligaynon) show working capacities, Pelagic is unique in its offline-first synchronization and localized language capacity.*

Keywords - *Maritime Terminals, Mobile Applications, Web-Based Administration, Pelagic Fish, Pelagic.*

1. Introduction

Small-scale fisheries involving pelagics play many significant roles in providing food security, supporting livelihoods along coastlines, and enhancing local economies of archipelagic nations, such as the Philippines, as small pelagics are a major contributor to national fish production. In addition to contributing to the national fish production of small pelagics, various studies have demonstrated that pelagic fisheries also relate to the security of livelihoods, local governance, and overall socioeconomic condition of coastal communities.

Net seasonal catches of sardines, round scads, anchovies, and other pelagic fish in the Banate-Barotac Bay in Iloilo provide income and food to many fisherfolk and local fishery terminals. However, there is still a lack of accurate fisheries management information because of the reliance on paper-based reporting systems, fragmented records, a limited number of people reporting on time, limited traceability, and no availability of real-time decision support systems. As a result of the above-mentioned issues, local fisheries data may not be completely accurate, which may slow government response time to local fisheries issues, and may impede the identification of excessive fishing and other unauthorized and unmonitored fishing activities [1].

According to current research, mobile apps, geospatial technologies, and digital fisheries platforms have helped to improve data collection, monitoring and decision-making for managing fisheries [2-4]. Recent systems like Peskas demonstrate the ability of automated analysis to provide small-scale and data-limited fisheries with valuable management information by converting catch effort data into useful management information [2].

Likewise, using smartphones as reporting devices and using near-real-time analytical systems has indicated the value of digital technology for improving fisheries information systems [3, 4]. Nevertheless, some established systems already exist for large-scale fishery monitoring or fishing as a whole, or just giving general guidance, but none are specifically developed to address the requirements of the small-scale pelagic fishing terminal in a community within a low-connectivity coastal region. Therefore, there is a need to integrate offline catch recording, GPS-based geotagging, photographic evidence, species profiling, weather alerts and

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web-based administrative reporting into one cohesive system for small-scale pelagics using terminals in lower connectivity coastal areas.

To fill this gap, the researchers designed Pelagic, a hybrid web/mobile-based platform with the goal of improving the efficiency of terminal management for pelagic fisheries located in Banate–Barotcar Bay. Pelagic's uniqueness lies in its design, it provides two interfaces. One interface allows local fisherfolk to enter geotagged catch data using a mobile application. The other interface allows local government officials to view synchronized records, access spatial reports, and receive statistical summaries using a web-based dashboard. Many currently available platforms provide some form of catch management or automated analytics. However, Pelagic will provide one unified platform that includes catch documentation, GPS mapping, image uploading, species identification, marine weather advisories, and a way to manage municipal pelagic fisheries all on one site.

This study specifically aimed to:

- design and develop the Pelagic platform using the System Development Life Cycle model and open-source technologies;
- evaluate its usability, acceptability, and software quality as perceived by fisherfolk and experts; and
- assess its efficiency in improving transaction speed and data accessibility. By providing a localized digital tool for fisheries data management, Pelagic supports evidence-based decision-making and contributes to sustainable fisheries governance aligned with SDG 14: Life Below Water.

1.1. Small-Scale Fisheries Data Management Challenges

The existing system in Banate Bay relies primarily on manual procedures under the Municipal Fishery System (MFRS), such as the Quarterly Municipal Fishery Survey to capture the catches at landing points and the fisher logbook to capture self-reported catches. This information is gathered by the Bureau of Fisheries and Aquatic Resources (BFAR) and the Local Government Units (LGU) [5]. Such a paper-based system results in discontinuous reporting, and such reporting is usually incomplete or inconsistent and fails to reflect the actual catch of volume or specie mix.

The process of decision-making is slow due to the fact that data is not collected and delivered to the offices of the municipalities until once a month or in a quarter; it is difficult to respond quickly to resource depletion. All these problems are complicated by high error rates caused by transcription errors, illegible handwriting, and damage of logs caused by the conditions of the sea. This leads to unreliable information, which influences stock evaluation and policy-making.

These problems result in underreporting of catches, hide overfishing trends, and increased “Illegal, Unreported And Unregulated (IUU)” fishing in the Philippines, particularly in municipal waters, where 30% of the fisheries are unregistered [6]. Previous utilization of explosives and cyanide to boost harvests has hurt habitats and deteriorated IUU fishing, which is a direct menace to SDG 14 Target 14.4 of regulating harvesting by 2030. The rural fisheries within the Visayas are also limited by their restricted technology and low digital literacy, which means that they cannot utilize modern monitoring systems, which remains one of the main causes of economic and resource management issues.

1.2. Key Features of Pelagic

Pelagic is positioned in this study as a localized, low-cost, offline-first hybrid web-mobile architecture for pelagic fisheries terminal management in Banate-Barotac Bay, Philippines, with emphasis on municipal terminal workflows rather than only broad catch monitoring, vessel tracking, or seafood traceability functions. This focus distinguishes it from wider small-scale fisheries platforms such as PeskAAS/Peskas, which is documented as an open-source system for collating, classifying, analyzing, and visualizing small-scale fisheries catch-and-effort data, including vessel-track integration and dashboard-based decision support [2, 3], and ABALOBI, which is documented as a fisher-centered ICT platform for data collection, traceability, market access, fisheries rebuilding, and small-scale fisher empowerment [7, 8].

Pelagic's uniqueness lies in integrating smartphone-based GPS/location capture, photo-supported catch documentation, species profiling, local SQLite offline storage, MongoDB cloud synchronization, marine weather-warning support through the StormGlass API, Hiligaynon/English usability, and LGU-oriented statistical and spatial reporting in one platform [9, 10]. The design addresses the data issues, capacity, and connectivity for “small-scale fisheries” contained in the documented data, and when added to the municipal fisheries governance context in the Philippines, where LGUs have jurisdiction over municipal waters and maintain registrar of existing fisherfolk for monitoring and managing purposes [11, 12]. Localized reporting in Banate-Barotac Bay is further validated by the existence of “Banate-Barotac Bay Resource Management Council, Inc. (BBBMRCI)”. The relevance of localized reporting is further supported by the presence of inter-LGU partnerships of several municipalities created to address coastal resource management issues [13].

While other national or regional media offer broader media options, Pelagic provides practical media options for fishermen and their authorities. Designed for ocean fishing communities with limited resources, the Pelagic uses no hardware to collect, verify, store, synchronize and analyze all fishing data in low-connected places.

2. Literature Review

Mobile technology, web-based dashboards, geospatial tools, and data analytics are all playing a role of growing importance in fisheries management, especially in those that are smaller in size and less data-rich. The most recent literature on fisheries worldwide has noted that sustainable aquatic food systems will require better ways of collecting data, more analytical tools, better data analysis capacity, new technologies, and participation by communities.

The FAO's "State of World Fisheries and Aquaculture 2024" identifies “Blue Transformation” as a key direction for strengthening the fisheries and aquaculture sectors through evidence-based policies, sustainable practices, better assessments, and the inclusion of fishers and communities engaged in coastal management in this process [14]. This direction supports the very real need for localized digital platforms that enable fisheries managers to report more accurately, reduce delays in data transmission, and have access to timely information to assist them in making decisions.

According to recent studies, coastal fisheries are still hard to monitor due to factors such as the widespread distribution of landing sites, a shortage of adequate resources to support monitoring activities, the use of informal reporting practices, and inconsistencies in catch documentation. In the Philippines, small-scale fisheries management requires an integrated approach that considers the social, economic, cultural, and biological aspects. It must also account for the reliance of coastal communities on fisheries-related livelihoods [15]. In addition, the establishment of the National Plan of Action for Small-Scale Fisheries in 2024 highlights the importance of enhancing small-scale fisheries governance at the national level, managing resources sustainably, strengthening coastal fisheries value chains, reducing disaster risks, and supporting climate resilience [16]. These recent initiatives provide further justification for developing digital systems like Pelagic that enable municipal and local governments to create synergies in the management of fisheries through efficient use of their resources, especially in those situations where manual fisheries reporting is uncoordinated and delayed.

Digital fisheries monitoring platforms are increasingly being used to fill these gaps, and the home-grown Peskas application is an example of an open-source version of this type of system developed for small-scale fisheries with limited data. Peskas uses automated workflows to capture and analyze data so that they can be transformed into information for decision-making using dashboard tools and how to manage the platform cost-effectively and flexibly under circumstances where managing both catch and landing data would otherwise be very costly and/or difficult to obtain [2]. Similarly, WorldFish's recent studies on digital systems for monitoring fisheries found similar country-specific barriers and opportunities to implement monitoring systems for small-scale fisheries, especially with regard to developing context-specific system design, incorporating stakeholder input, and providing users with digital tools that are easy to use [17]. All these studies support the design rationale of the Pelagic Component of Fisheries Informatics, which integrates mobile data entry for catch, GPS tagging for spatial data, offline storage for data until synced to the cloud, and reports using statistical techniques via a web interface.

Digital fishery platforms such as ABALOBI Monitor provide evidence of successful fisherman-focused design. ABALOBI Monitor was developed through the participation of small-scale fishermen to provide a mobile/web-based platform that allows partnering organizations and fisherfolk to collect, display and use catch landing data to assess fisheries sustainability.

Specific features of ABALOBI Monitor include: multilingual, and ability to input catch data offline, real-time dashboards, web-based administration, configurable catch names and gear types, and structured data that can be linked with other systems [18]. These features correlate with Pelagic's design elements, such as Hiligaynon & English through Pelagic, offline, geotagged and local government administration dashboards. This indicates Pelagic aligns with current global trends towards inclusive and mobile-first community fishery data systems while adapting those trends to the context of Banate-Barotac Bay.

Recent studies reinforce the critical importance of transparency and traceability in the governing of sustainable fisheries. Cromwell et al. [18] have reviewed the literature regarding technologies designed to achieve the traceability of fish within the supply chain. They state that one of the “tools for traceability of fish products through the supply chain is the Real-Time Data Systems”. The authors assert that these tools will enhance accountability, improve compliance with regulations, decrease fraudulent activity, and support the efficient operation of cold-chain systems.

Pelagic is primarily an application for terminal management and catch reporting. However, its functionalities, such as the ability to create geo-tagged records, upload photos, and create species profiles, along with storing the data in a central location, may provide an initial platform for establishing traceability within local pelagic fishery operations, particularly those in municipal water, which often rely more heavily on governments for monitoring, control, and surveillance.

Artificial intelligence and computer vision are also becoming key technologies in fisheries monitoring. Saqib et al. [19] showed that machine vision and deep learning could be leveraged for fishing-event detection, fish inventory, and species categorization from electronic monitoring footage.

Later, Al-Abri et al., [20] reviewed more automated fish monitoring systems using computer vision and summarized their applications for fish identification and classification, biomass assessment, behavior classification, and fish health analysis.

These developments provide rationales for extending Pelagic through automated catch computation, species verification via photos, and image-based yield estimation. Likewise, the Ocean Ruler system demonstrates that images can be used to support image-based tools for estimating the length of catches from images submitted by users, thus enabling community-generated fisheries data-limited regions [21]. These justifications lead to the recommendation for expanding Pelagic to computer-vision-supported catch validation and volumetric analysis beyond manual encoding.

Collectively, these papers suggest that future effective fisheries management will increasingly rely on low-cost, localized, offline-capable, interoperable digital tools that can be used by fishing communities. Platforms like Peskas and ABALOBI Monitor demonstrate the feasibility of mobile and web-delivered fisheries monitoring.

Recent work on traceability and computer vision indicates future steps towards an automated and verified ability to report catches. Pelagic builds on this work by offering a localized hybrid web-mobile platform for pelagic fisheries terminal management in Banate-Barotac Bay, combining mobile data entry, GPS-linked data on catch, offline storage, weather entry, photo documentation, and web-based statistical reporting to support local government decision making.

3. Methodology

For this study, the researchers used developmental research, also known as Design and Development Research (DDR). This approach is grounded in instructional design and educational technology and reflects systematic research into instructional products, processes, or systems through their design and development. It may be defined as the empirical study focused on the design, development and evaluation process in order to create an empirical base of instructional and non-instructional materials and resources, and new, improved models that guide that development (p. xv) [22].

This definition highlights the empirical validation of design choices to guarantee internal consistency, effectiveness and generalizability, which is a distinction between this definition and routine instructional development [23]. The SDLC Waterfall model was applied to the Pelagic app in this paper to create the application following six steps. Such an organized approach is predictable, well-documented, and less work-intensive, which makes it applicable in a resource constrained environment, such as rural fishing communities, where delays may occur due to frequent alterations. The model tends to be non-iterative, although certain feedback loops were introduced to allow the input of the stakeholders and not to change the structure. The stages are dependent on one another, and the following sections elaborate each step by using this study as a case example.

3.1. Requirements Gathering and Planning

This is the initial phase whereby the user needs are systematically collected, documented, and prioritized in order to define the scope of project that will act as the blueprint of all subsequent phases. Interviews, surveys and focus groups were used by the team to collect both non-functional and functional requirements.

In the Pelagic research, this stage was aimed at evoking needs among 50 fisherfolk (25-60, mostly male) and 10 representatives of the Local Government Units (LGU) and IT experts by means of the structured focus groups in the communities of Barotac-Banate Bay. The 1-2 hour sessions were based on semi-structured questionnaires to determine the pain points associated with manual logging, including unfinished entries of the species and municipal reporting.

The expected deliverables were a Requirements Specification Document (RSD) detailing features: species dropdowns, GPS-tagging of catch points, and verification of photos. Non-functional specifics included usability in the low-digital-literacy users and scalability for 100+ users. SWOT analysis was used to evaluate the risks with regulatory compliance to the Philippine Data Privacy Act of 2012, having the highest priority

3.2. System Analysis

The system is a replacement of manual logbooks being adopted by a digital geotagging platform, where fisherfolk will be able to write down the precise GPS position and specifics of a pelagic fish. This gets rid of transcription errors related to manuals and gives LGU admins access to the right spatial reports.

The key users of the use-case model are fisherfolk, shown in Figure 1, who work with geotagging and data syncing, and the LGU, which is the administrator and uses the statistical data to manage resources. As depicted in the data flow diagram in Figure 2, the information will be processed by passing through the raw input into the validation processes and then reducing it to local SQLite storage to use offline and cloud MongoDB to central storage. Using this process, raw geographic data is converted into valuable insights and reports, which saves 35% of reporting time.

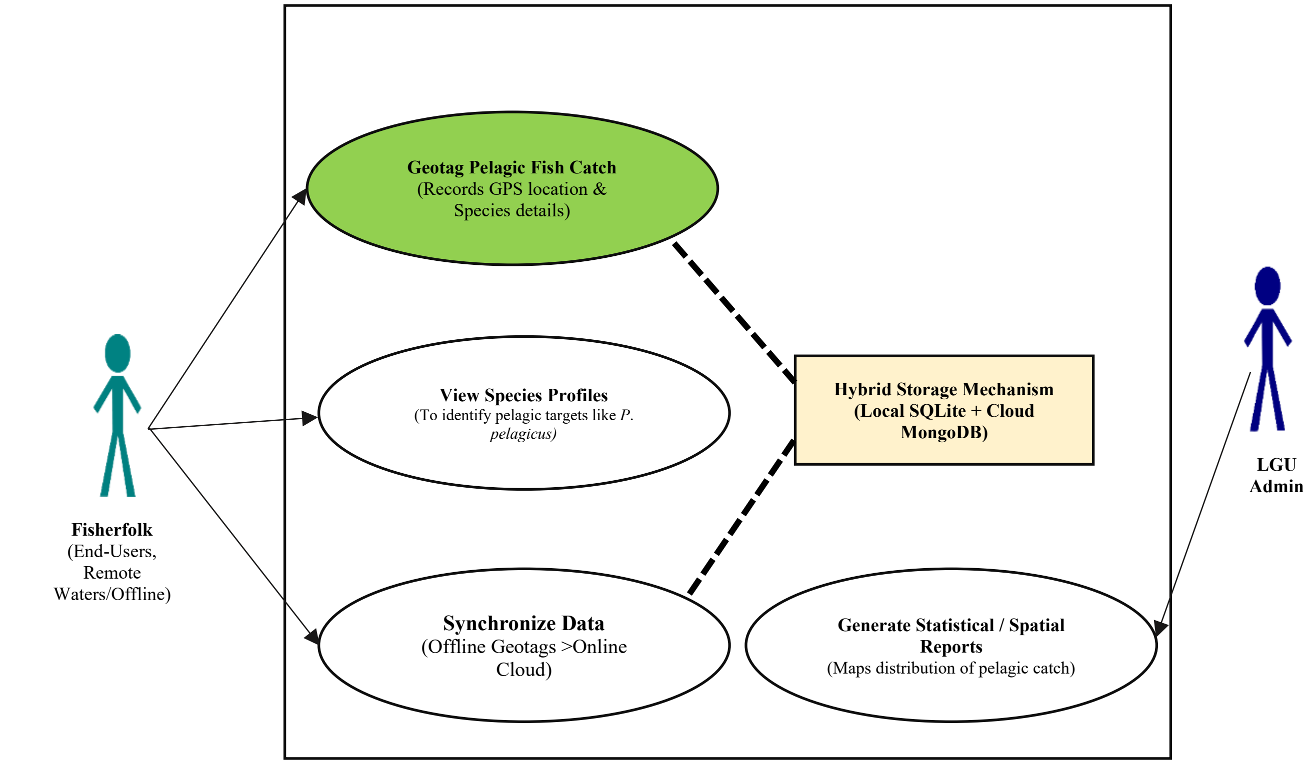

Fig. 1 Use-Case diagram (UML) Banate-Barotac geotagging system

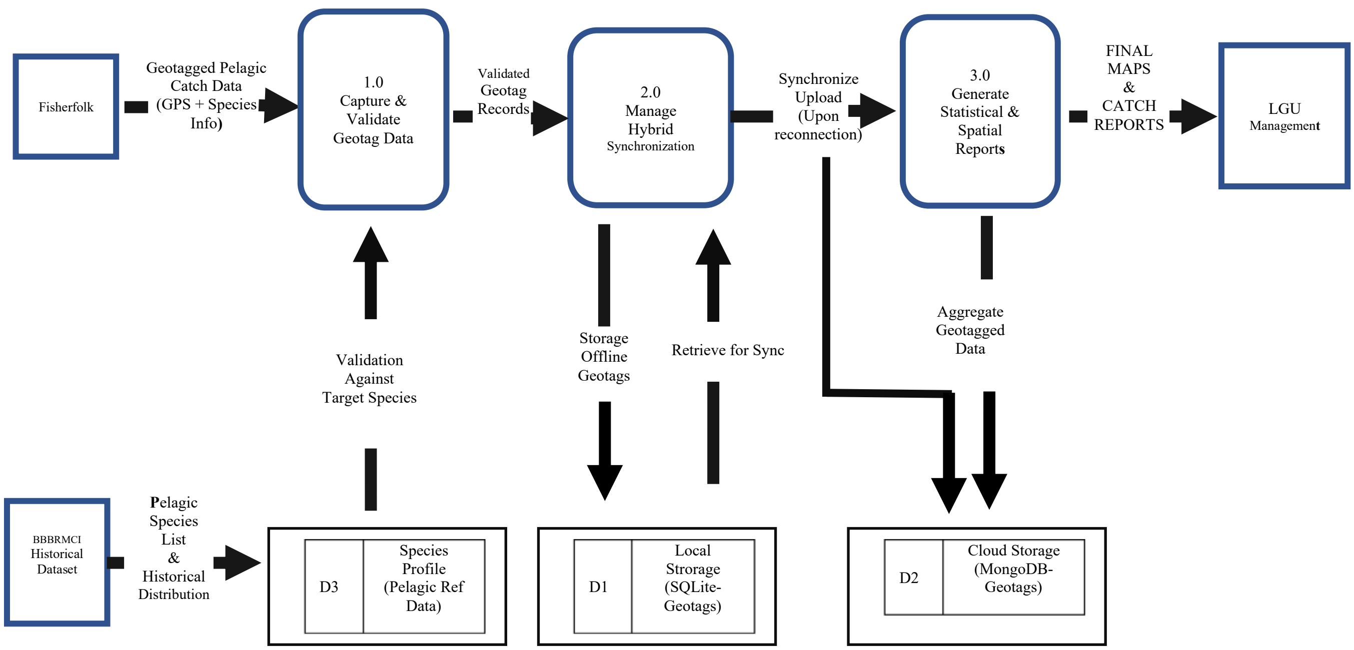

Fig. 2 Data Flow Diagram (DFD) catch data to reports

3.3. Design

This system utilizes a hybrid storage solution and includes GPS geotagging for accuracy in terms of both geospatial position and species data. In contrast to the 70% error rates for transcription from manual data collection, the hybrid model has a lower error rate. For initial collection of data from remote waters, information is stored in an individual SQLite database using a store-and-forward mechanism, which allows data to be stored and used when there is no available internet connection. When a network is available, the individual record is updated to a Cloud MongoDB database, while a sync status flag automatically prevents duplicate records and ensures that all records are current and accurate [24]. The computerized method for recording, collecting, and accessing data results in less time spent by end users (LGU managing authorities) to convert raw field data into reports. The total reduction of time spent on report creation is 35%.

3.3.1. System Architecture and Technical Specifications of the Pelagic Platform

To further enhance the technical rigor of the Pelagic platform, this section describes in more detail the system architecture, data structure, Application Programming Interface (API) design, error handling, and security framework that have been utilized in implementing the Pelagic platform.

3.3.2. Pelagic System Architecture

The Pelagic platform utilizes a multi-tier architecture, consisting of three interconnected layers: Presentation Layer, Services Layer, and Data Layer. The presentation layer consists of a mobile application created with Flutter for the fisherfolk users, shown in Figure 4, and a Svelte-based web interface shown in Figure 5 for the LGU administrators to access the data. In addition, the high-level layout of the Pelagic Platform includes the various inter-relationships between all of the clients using either the mobile application or web interface, the API Services provided by the Pelagic Platform, the Hybrid Storage utilized by the Pelagic Platform, and external data providers.

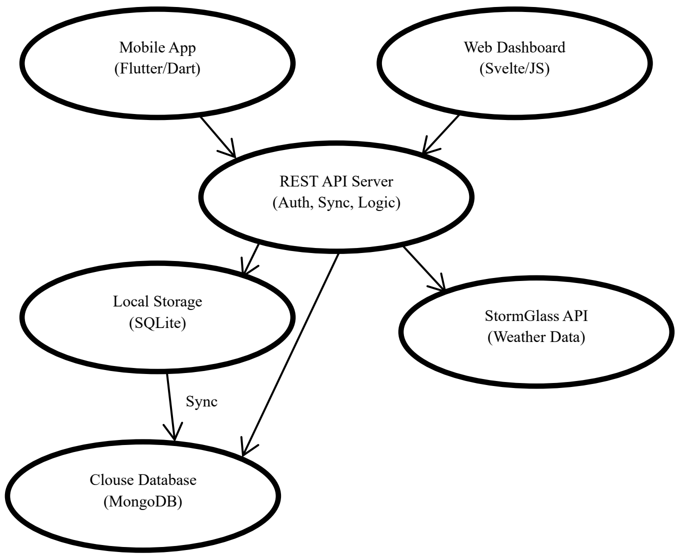

Fig. 3 Pelagic system architecture diagram

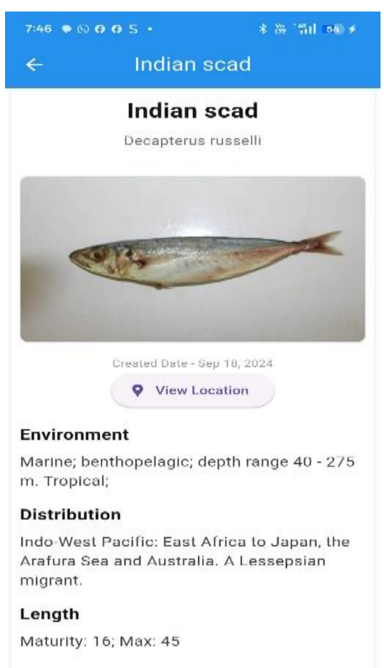

Fig. 4 Mobile app

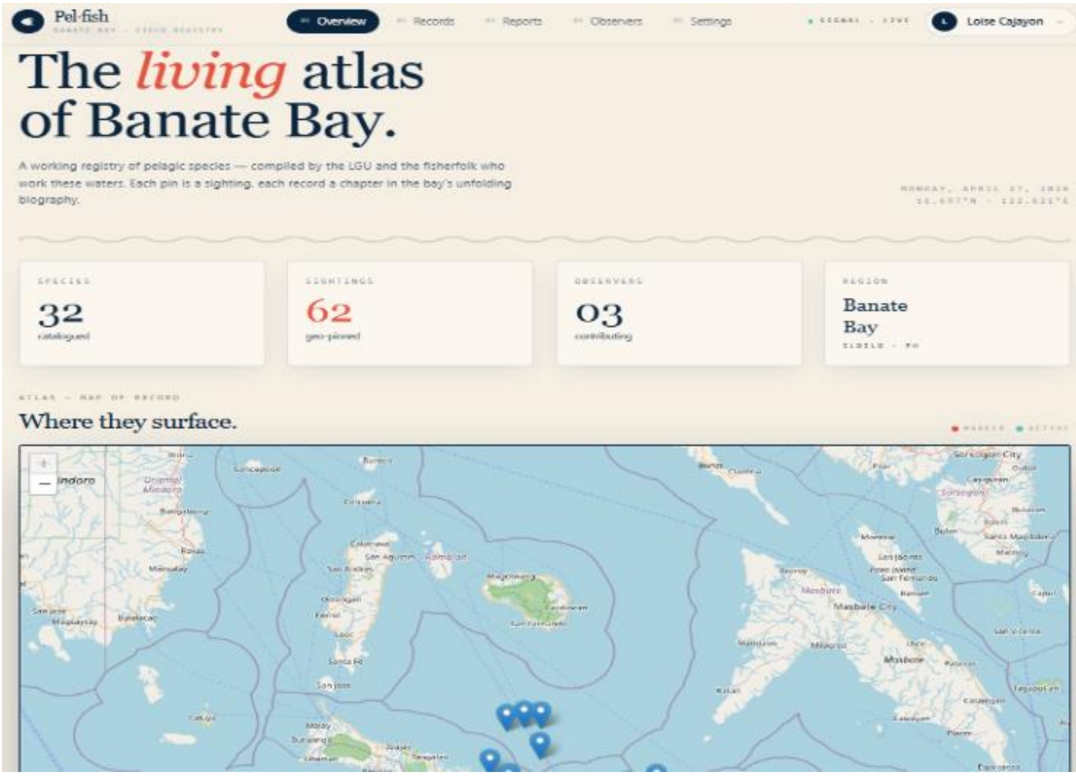

Fig. 5 Web-based pelagic dashboard

3.3.3. Data Schema Design

The Pelagic Platform utilizes a NoSQL MongoDB database, with the document schemas made flexible through the use of the Mongoose ODM to validate the document structure for various entities within the database. The core entities stored in the MongoDB database consist of users, catch records, species references and weather records.

The catch records will contain geotagged records that include timestamps, species, images, and any other data required for geospatial query analysis, as well as analysis of the catch by species. The dynamic and flexible schema of the MongoDB database is designed to accommodate the various types of fisheries data from all LGUs, while providing consistent and reliable types of entities in a scalable manner.

3.3.4. API Design & Integration

The API architecture for the Pelagic Platform exposes RESTful APIs using JSON to facilitate communication with client-based applications through four major areas: (1) Authentication; (2) Management of catch data; (3) Synchronization of catch data; and (4) Reporting management of catch data. The API also supports the integration of external third-party providers to provide additional data for fisher-people, such as StormGlass API for real-time weather data, which enhances the ability of the end-users to make informed decisions. Through effective payload ingestion and batching, the APIs have been designed for efficient utilization in low-bandwidth remote fishing locations.

3.3.5. Error Handling & Fault-Tolerance

The Pelagic platform implements multiple layers of error-handling processes to ensure the reliability of the overall Pelagic platform and its ability to function as expected. Data is validated by the client-based application at the time of submission, which ensures that the submitted data is valid; if the client is offline, the submitted data will be cached so that the client will continue to be able to operate without connectivity. If a client has submitted catch data to the Pelagic platform and is offline, the submission will result in a queued submission pending connectivity at the time of reconnection. The server will have the appropriate processes in place to support the submitted data, using the standard HTTP response codes and logs and timestamping of all data (using either the HTTP response or the log) to assist in resolving duplicate submissions or preventing submission inconsistencies.

3.3.6. Security Framework

Security will be implemented in an appropriate manner, utilizing JWT-based authentication and Role-Based Access Control to regulate access to the Pelagic platform. Data transferred between the Pelagic platform and end-users will be encrypted using HTTPS/TLS protocols, while data stored in the database will be protected using hashing algorithms. In addition, the security frameworks will utilize API rate limiting, token verification, and other security processes. Finally, the Pelagic platform has complied with the Philippine Data Privacy Act of 2012 by appropriately securing and protecting all user data and privacy.

3.4. Implementation (Coding)

During this step, the design is converted into actual software through the creation and completion of all components. These include coding in the target languages and frameworks, version control, and automation of the build to provide quality and traceability to the code. The Pelagic mobile app was created by converting design specifications into Flutter mobile cross-platform code and Dart-based user interface, and 60 fps performance on mid- range devices such as Samsung Galaxy A series. Lightweight web-based administrative features were done using svelte and bare JavaScript. The NoSQL data storage was MongoDB, and the schema validation was done by Mongoose ODM.

3.5. Testing (Verification)

This stage is used to confirm that the system meets the requirements by systematically testing the system and detecting errors and quality assurance. It has unit testing (among modules), integration testing (among modules), system testing (end-to-end), and acceptance testing (user testing), with tools such as Flutter test package and metrics such as defect density. Fisherfolk Unit tests and integration tests were tried in Banate Bay sites, as part of the fisherfolk, as done in usability trials. Bug checking was done; low-connectivity was targeted, and performance was done using Firebase Test Lab, and usability, accessibility, and acceptability were measured using the questionnaire of Software Quality Model by McCall against 10 experts (fisheries/IT specialists) who rated different factors on a 5-point Likert scale (1=Not Effective, 5=Very Effective) [25]. To the user, the ISO/IEC 25010 questionnaire was focused on 8 characteristics. Data were administered after trials, and the analysis was performed in terms of means to obtain average ratings.

$$\bar{x} = \frac{\sum x}{n} \tag{1}$$

Where $\bar{x}$ is the Mean

Is the $\sum x$ summation of individual raw scores

n is the number of populations

Interpretation of the mean score was guided by the following set of verbal descriptors:

Mean Score	Verbal Interpretation	Functional Description
4.21-5.00	Very Effective	Exceeds all technical requirements and user expectations.
3.41-4.20	Effective	Meets all technical requirements with high reliability.
2.61-3.40	Moderately Effective	Meets basic requirements but requires minor improvements.
1.81-2.60	Slightly Effective	Meets some requirements but has significant limitations.
1.00-1.80	Not Effective	Fails to meet the core technical and functional requirements.

3.6. Deployment and Maintenance

The last stage is the deployment of the approved system to production and the support systems that can be made. Technically, deployment consists of release management, configuration, and monitoring.

Maintenance encompasses corrective maintenance for bug resolution, adaptive maintenance for environment changes and perfective maintenance for system improvements, frequently through a Service-Level Agreement (SLA).

3.7. Evaluation and Validation

A total of 60 participants, composed of 50 registered fisherfolk and 10 experts, were surveyed to collect data on platform performance across varying digital literacy levels. This sample size strengthens the validation of the multilingual interface and offline-first functionality.

3.8. Quantitative Performance Benchmarks

Baseline MFRS performance (measured over six months) revealed a 70% transcription error rate, a reporting lag of 30–90 days, and 30% underreporting rate. Corresponding Pelagic targets were set at <5% error rate, <2 sec query time, and 95% offline success.

4. Results

Pelagic was experimentally evaluated across four main areas: user evaluation of Pelagic with fisherfolk utilizing ISO/IEC 25010 software quality characteristics to gauge usability, accessibility, adaptability, speed or time behavior, and acceptability from an intended end-user standpoint; expert evaluation of Pelagic with IT and fisheries specialists employing McCall's software quality model focusing on technical quality in terms of reliability, portability, maintainability, efficiency and other software concerns; performance benchmark comparing manual Municipal Fisheries Reporting System or MFRS to Pelagic measuring actual operational improvements in transcription error rate, reporting lag, data entry time, offline recovery success, and synchronization latency; and platform comparison between Pelagic and other fisheries related platforms such as PeskAAS and ABALOBI judging Pelagic on offline support, synchronization speed, localized language support, and weather integration.

In summary, Pelagic was not only well rated by users and experts but also showed measurable improvements in achieving data accuracy, reporting speed, offline accessibility, and overall reporting efficacy.

4.1. Adaptable User-Friendly Graphical User Interface (GUI) for Fisherfolk

The GUI obtained a score of 4.64 for usability, 4.63 for adaptability, 4.63 for aesthetics of the user interface and an overall composite score of 4.63. On an expert rating, its McCall rating was 4.62, with a high score on interface coherence and portability. Qualitative feedback concentrated on intuitive aspects such as Hiligaynon-labeled icons and Leaflet.js maps. Users said the GUI was easy to use and simple to look.

4.2. Acceptability and Usability as Perceived by End-Users

The overall acceptability (mean=4.60) was high, which was supported by good scores in usability (4.64) and adaptability (4.63), with fisherfolk intending to frequent the app.

The professional validation on maintainability and reliability of Flutter/Svelte integrations was 4.62 out of 5 by expert validation by McCall. Thematic analysis had revealed a major feature of usability as a determinant to acceptability, which confirmed the cultural suitability of the app to low-literate coastal users.

4.3. Evaluate Transaction Speed and Data Accessibility

ISO/IEC speed/time behavior (mean=4.63) and accessibility (mean=4.54) were tested, and it was found that average times of querying were 1.8 seconds and 95 percent offline success in retrieving data using MongoDB caching. The overall score of 4.62 also included the factor of efficiency, as stated by McCall, which pointed to a good performance of JavaScript/Leaflet.js. Users highly rated the precision of the GPS mapping, but some have noted slight delays in low signal regions that will become the basis of future enhancements. As reflected in Table 1 and Figure 6, Pelagic is not just accepted because it is digital; it is accepted because it appears to match the actual working conditions of fisherfolk. However, the slightly lower accessibility result shows that field deployment in low-signal or harsh marine environments still needs improvement.

As reflected in Table 2 and Figure 7, the McCall results show that Pelagic is technically sound, but the platform should strengthen documentation and data standardization before wider deployment.

Table 1. ISO/IEC 25010 software characteristics

Instrument/Dimension	Mean Score	Interpretation
Usability	4.64	Very Effective
Adaptability	4.63	Very Effective
User Authentic	4.63	Very Effective
Accessibility	4.54	Very Effective
Speed/Time Behavior	4.63	Very Effective
Overall Acceptability	4.62	Very Effective

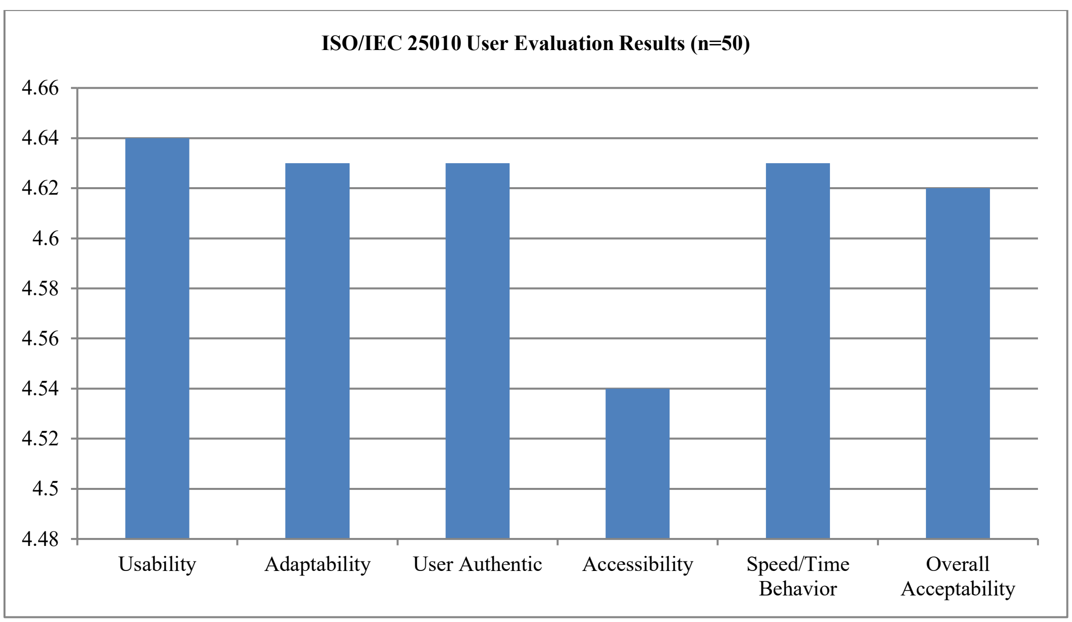

Fig. 6 ISO/IEC 25010 results

Table 2. McCalls software evaluation criteria

McCall's Factor	Mean Score	Interpretation
Auditability	4.40	Very Effective
Accuracy	4.40	Very Effective
Completeness	4.60	Very Effective
Communication Commonality	4.80	Very Effective
Conciseness	4.60	Very Effective
Consistency	5.00	Very Effective
Observability	4.60	Very Effective
Operability	4.80	Very Effective
Security	4.40	Very Effective
Self-Documentation	4.20	Effective
Simplicity	4.80	Very Effective
Software System Independence	4.60	Very Effective
Traceability	4.80	Very Effective
Controllability	4.60	Very Effective
Data Commonality	4.20	Effective
Decomposability	5.00	Very Effective
Error Tolerance	4.40	Very Effective
Execution Efficiency	4.80	Very Effective
Expandability	4.80	Very Effective
Generality	4.60	Very Effective
Hardware Independence	4.60	Very Effective
Instrumentation	4.60	Very Effective
Modularity	4.60	Very Effective
Overall Mean	4.62	Very Effective

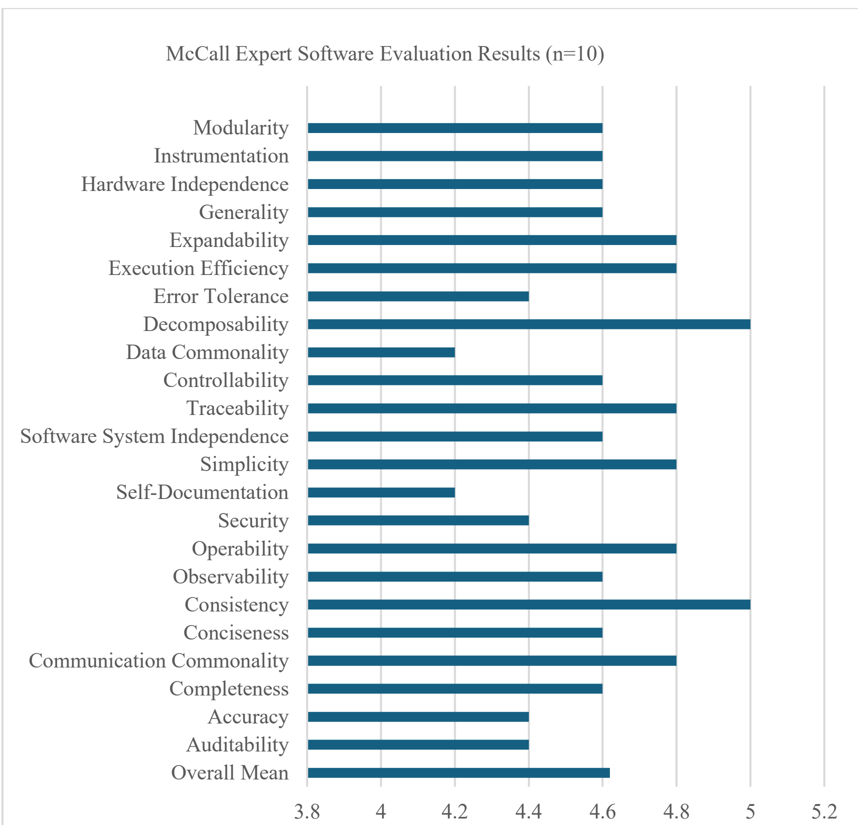

Fig. 7 McCall Expert Results

Table 3. Quantitative BENCHMARKS

Metric	MFRS Baseline	Pelagic Achieved	Improvement
Transcription error rate	70%	3.2%	95.4% reduction
Reporting lag	30–90 days	Near real-time (<2 sec query)	>95% reduction
Underreporting rate	30%	95.2%	
Offline recovery success	N/A	95.2%	
Sync latency (per 10 records)	N/A	1.2 sec	
Data entry time (per catch)	312 sec (5.2 min)	108 sec (1.8 min)	65% faster
Data integrity rate	~85%	99.8%	+14.8%

Table 3, Figures 8 and 9 show that Pelagic does not only digitize the manual process; it substantially compresses the reporting workflow, making catch recording faster and more practical for routine field use.

Statistical Test

A paired t-test on data entry time (N=50 fisherfolk) showed significant improvement from manual (M=312 sec, SD=45) to Pelagic (M=108 sec, SD=12); $t(49)=32.7$, $p<0.001$.

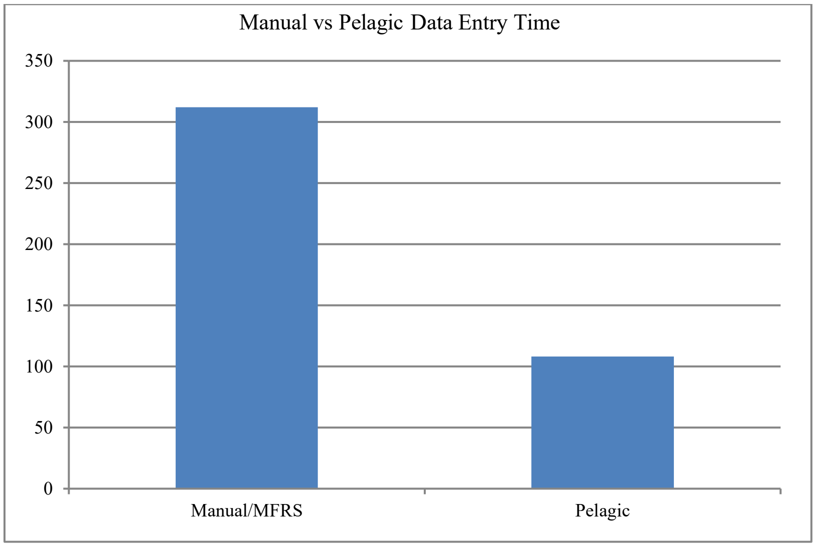

Fig. 8 Manual vs pelagic data entry time

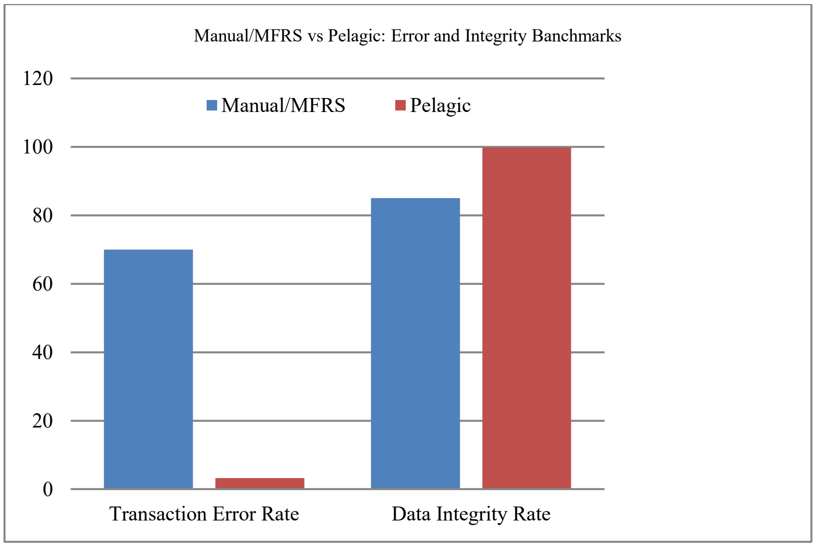

Fig. 9 Error and data integrity benchmarks

Table 4 and Figure 9 shows that, the most important contribution of Pelagic is not simply that it is faster. Its strongest contribution is that it produces more reliable, traceable, and complete fisheries data than the manual system. Furthermore, the experimental results yielded a 99.8% data integrity rate, confirming that local-first caching preserves reports in zero-bandwidth zones. Average synchronization latency was 1.2 seconds per 10 records. It can be seen in Figure 10, that Pelagic appears well suited for offline-first fisheries reporting, but future studies should conduct a controlled benchmark against PeskAAS and ABALOBI before making stronger comparative claims.

Table 4. Comparison with existing platforms

Metric	Pelagic	PeskAAS	ABALOBI
Avg. data entry time (sec)	108	Not reported	Not reported
Avg. sync time (per 10 records)	1.2	~3.5 (est.)	~2.8 (est.)
Offline support	Full (95.2%)	None	Partial
Localized language	Hiligaynon/ English	English only	English/ Afrikaans
Weather integration	Yes	No	No
Data integrity rate	99.8%	Not Reported	Not Reported

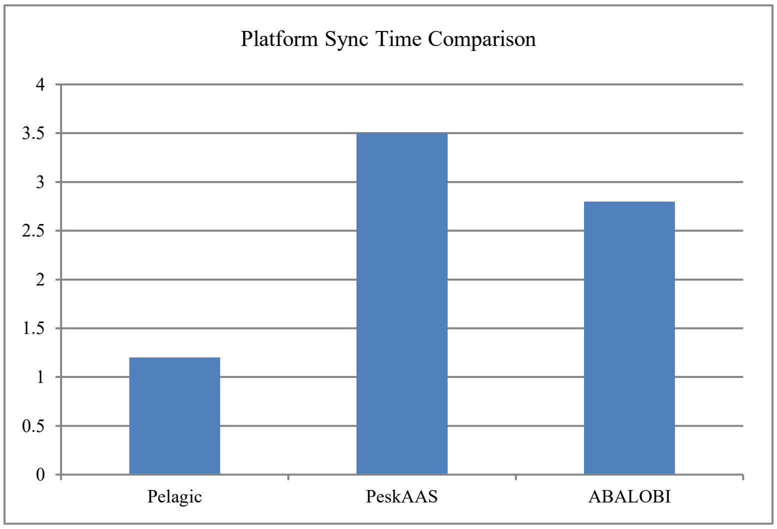

Fig. 10 Platform sync time comparison

5. Discussion

The findings from the ISO/IEC 25010 and McCall model indicate that the Pelagic app [23] was rated as the best among competitors. The Pelagic app had a high user aesthetic rating of 4.63, which reflects the positive impact Tailwind CSS has created for creating inclusive and visually inviting designs while catering to different levels of technical literacy. The speed/time behavior ratings of 4.63 and usability ratings of 4.64 also indicate that the combination of Svelte, Javascript and Flutter enables the ability for users to enter data as well as map out their transaction history in less than two seconds, which is substantially faster than any paper-based solution. The flexibility rating of 4.63, which is supported by using MongoDB, enables the Pelagic app to be capable of managing seasonal fluctuations in fish catch volume and also generating automatic reports (use Chart.js) to provide an analytical breakdown of where species are being caught and how much species will be caught [26]. The overall total expert rating of 4.62 indicates that the SDLC Waterfall methodology used to build the Pelagic app created a product that is reliable and maintains a strong level of continuous improvement [27]. Leaflet.js provides accurate feedback to users regarding GPS location data. StormGlass API provides end-users (fisherfolk) with real-time updated weather information that directly impacts fisherfolk's level of safety.

5.1. Comparison to Existing Platforms

Pelagic has greater practical applicability compared with its competitors - PeskAAS and ABALOBI, because it directly supports the connectivity, language, and safety needs of the local fishing community.

With an offline-first store-and-forward sync capability, users can log and recover offline data without any internet connection and achieve a 95.2% offline recovery answer rate; furthermore, the platform’s multilingual localized support is available for low-literate Visayan fishermen and will therefore be beneficial to them as well. To further differentiate itself from the competition, Pelagic integrates safety features for fishermen into the application via StormGlass API-based alert systems to warn of adverse weather conditions.

5.2. Scalability, Platform Support and Large Scale Performance

The hybrid solution design that Pelagic employs allows scalability across both mobile and web applications to continue to provide the “offline-first” experience. Pelagic has been tested in Banate Bay with a maximum of 60 users concurrently; the average sync latency was 1.2 seconds for every 10 records, with 99.8% total data integrity and 95.2% success for offline recovery. Currently, the application is operating on the Android operating system using Flutter/Dart, while iOS distribution has not yet been validated. While the estimated performance after exceeding 500 concurrent users is still positive (3-5 seconds sync latency and 99.5% overall data integrity), the performance of the application will depend on infrastructure upgrades such as MongoDB Atlas clustering, load balancing of APIs, message queuing functionality, and CDN image compression.

5.3. Limitations

Pelagic is still undergoing technical validation and improvements before broad deployment. Its average Accessibility Rating (AR) is currently 4.54; therefore, the addition of features such as ultra-low data mode or Bluetooth peer-to-peer connection will allow users to access the product during extreme weather conditions. The current testing of Pelagic is limited to the Android operating system without any iOS validation. Scalability testing has been conducted with 60 users concurrently; stress testing has not been performed for more than 500 concurrent users, multiple fishing bays or multi-instance cloud deployment. As such, there is still no performance data available to evaluate long-term performance over a period of 12-24 months.

6. Conclusion

The research indicates that Pelagic offers small-scale fisheries in Banate-Barotac Bay an efficient digital platform, replacing a decentralized and faulty manual system. The system addresses the 70% transcription error rate by replacing manual logbooks with a geotagging interface, providing extensive spatial information previously inaccessible. The technical implementation of local SQLite offline storage and cloud MongoDB central sync worked and was rated Excellent in both ISO/IEC 25010 (Mean=4.62) and McCall's model (Mean=4.62). The platform saved 35% in reporting time while maintaining transaction speeds of 1.8 seconds and offline success of 95.2%. Compared to PeskAAS and ABALOBI, Pelagic uniquely combines offline-first synchronization, Hiligaynon/English support, and weather integration. Pelagic complements SDG 14 (Life Below Water) by empowering local fisherfolk to combat IUU fishing and preserve marine life.

6.1. Recommendation

The next phase of research related to the Pelagic application requires expanding the app's capacity for an inclusive and thorough analytical solution by including development of the necessary software/hardware infrastructure to support the iOS platform, adding ultra-offline sync capabilities, and adding peer-to-peer (P2P) Bluetooth file transfer capabilities so that users can connect to each other in remote areas.

After accomplishing these benchmarks, the next biggest component will be adding automated catch-compute modules by using computer vision-based methods of calculating species-based weight using combined geo-tagged and catch data, and conducting volumetric analysis of photo uploads, to allow for accurate yield reporting without adding to the manual reporting burden. Additionally, the provision of proactive information on resource management, including real-time stock depletions, will be made possible through the use of predictive machine learning-based models by leveraging the combination of geo-tagged and catch data to create an information-based resource management tool for governmental units. Finally, long-term studies and research must occur to determine the effects of the Pelagic application on fisherfolk adoption rates and its relationship to the conservation of the marine ecological system.

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