

# PescApp: Mobile Decision Support for Enhancing Operational Efficiency in Artisanal Fisheries

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*Abstract— Artisanal fishing remains a vital source of livelihood for many coastal communities in Peru. However, the sector operates with limited tools and technologies for planning and decision support, making it difficult to achieve efficiency and profitability. In response to these challenges, this article presents PescApp, an Android-based mobile application designed to support decision-making in the operational management of artisanal fisheries in the port of Matarani, Arequipa. The tool was co-designed with local fishers and covers key stages of the fishing journey: cost estimation before departure, real-time trip monitoring using GPS, and a post-trip assessment of profitability. One of its features is a decision-support module that provides operational recommendations based on business rules derived from experts' knowledge of artisanal fishing practices. We tested the app with 14 artisanal fishers, using two standardized evaluation instruments (a questionnaire based on ISO/IEC 25010 and a User Experience Questionnaire), focusing on usability and overall experience. Feedback was highly positive; participants appreciated the simplicity of the interface and the way it helped them better understand the financial outcomes of each trip. The results revealed high levels of user acceptance and satisfaction, particularly among younger fishers seeking to improve their planning skills. The successful adoption of PescApp demonstrates how purpose-driven technological innovation can help address long-standing inefficiencies in artisanal fisheries.*

**Keywords -- Artisanal Fishing, Mobile Application, Decision-Making Support, Digital Transformation.**

## I. INTRODUCTION

Fishing is a fundamental economic activity along the Peruvian coast, with artisanal or small-scale fishing being the primary source of employment in the sector. However, this subsector has one of the highest rates of informality in the country, reaching an alarming 97% [1]. Fishermen and shipowners, who have often learned their trade empirically, focus their efforts on operational production activities, ignoring key aspects such as financial planning, cost management, occupational safety, and the profitability of their work [2].

At the same time, Peru has experienced widespread smartphone adoption, reaching 84% of the population in urban areas [4]. Despite this progress, primary economic sectors such as fishing have remained largely untouched by this technological development and adoption for work activities. In other parts of the world, initiatives such as Fisher Friend in India [5] have utilized satellite data to optimize fishing routes. However, there are no mobile applications on the Peruvian market explicitly designed for the comprehensive management

of artisanal fishing. The use of smartphones at sea is generally limited to recreational activities.

This digital gap represents a missed opportunity to strengthen the sector's development and productivity, as promoted by the Food and Agriculture Organization of the United Nations (FAO) [6]. The lack of technological tools for recording and analyzing operational data prevents fishermen from making informed decisions that could significantly improve their profit margins and the long-term sustainability of their activity.

This article presents the development and validation of PescApp, a mobile application designed to close this technological gap. The primary objective is to provide a digital tool that supports the operational management of artisanal fishing, enhances planning and cost control, and contributes to increasing the profitability of fishermen. The project is presented as a clear example of innovation with both social and technological purposes, aligning with the need to digitize traditional productive sectors to ensure their competitiveness and sustainable development.

## II. METHODOLOGY

This work represents applied and technological research, with a mixed approach that combines quantitative data analysis (costs, profits, navigation data) and qualitative data analysis (interviews, perception questionnaires). The methodological design was structured in three main phases, ensuring that the final product was aligned with the real needs of users.

### A. Modeling and Collaborative Design Phase

A co-design approach was used to ensure that the application responded to the needs of the end user. The process began with a documentary review of technical and government reports to understand the value chain of artisanal fishing [3, 7]. This information was verified and enriched through semi-structured interviews with the president of the fishermen's association, which made it possible to map the actual workflow and define the functional requirements of the application. This process culminated in the development of a detailed flowchart of the fishing process (Fig. 1), which served as the basis for the design of the application.

### B. Software Design and Construction Phase

The application was built using an iterative development approach, which allowed the product to be adapted to requirements that evolved throughout the project. This process

facilitated continuous and direct collaboration between the development team and representatives of the fishermen's association. Development was carried out natively for the

Android platform, as it is the dominant mobile operating system in Peru (73.09% of the market) [8].

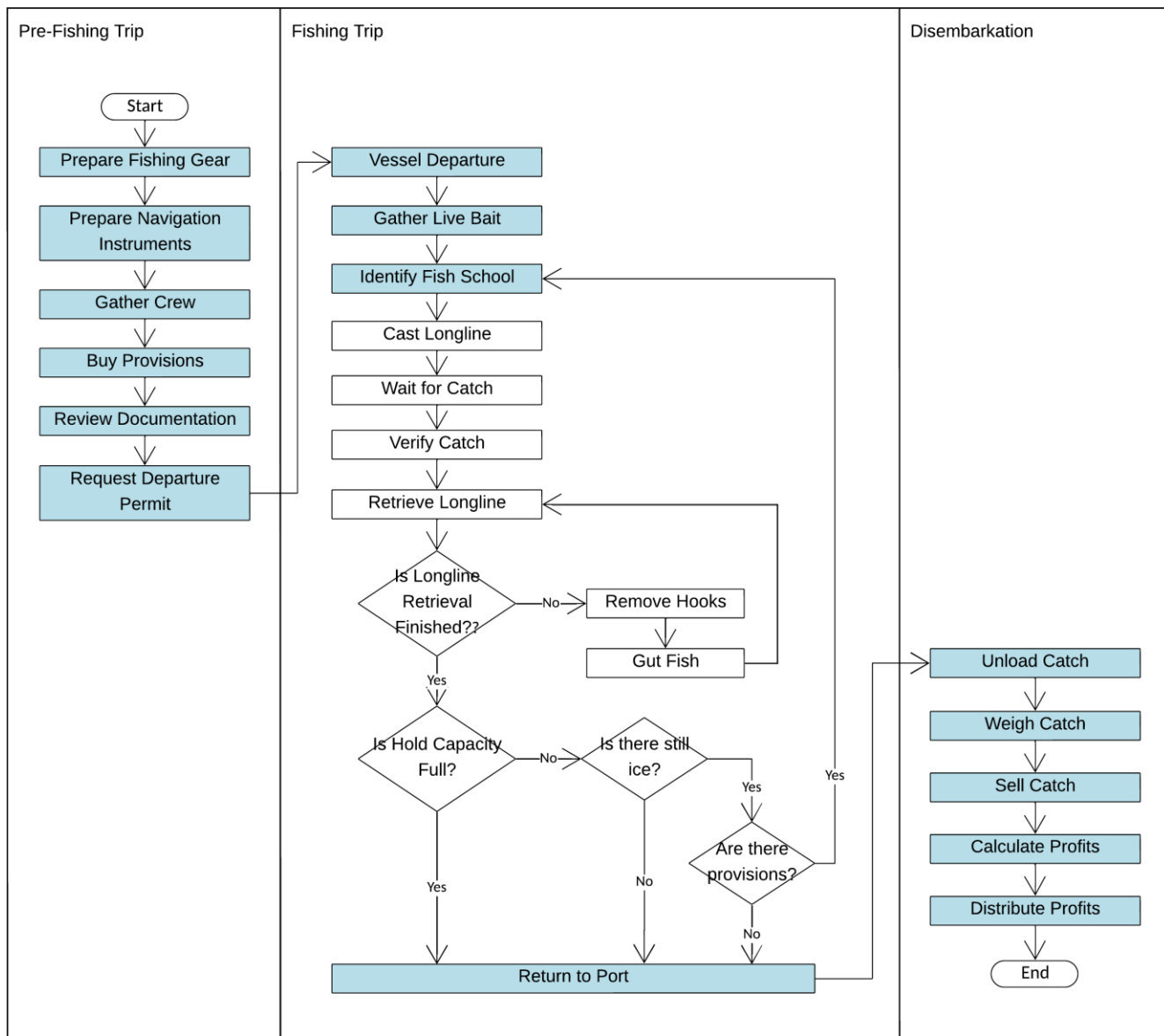


Fig. 1- Flowchart of the identified artisanal fishing process.

### C. Validation Phase and Case Study

The prototype was tested and validated in a case study with the company of shipowners, fishermen, aqua culturists, exporters, and artisanal seafood processors of Islay (EMARPAEXPRO), an association in the port of Matarani. The team obtained the sample for user experience validation for convenience., including 14 fishermen from the association who participated voluntarily for convenience. We carried out the validation using three instruments:

1) *Functional Tests*: Performed in the laboratory and in field tests at sea to verify the operability of all modules, especially the GPS tracking module.

2) *Usability Evaluation*: Performed using a questionnaire designed by Nayibe et al. [9], based on the criteria of the ISO/IEC 25010 standard (Intelligibility, Learning, Operability, etc.).

3) *User Experience (UX) Evaluation*: Measured using the UEQ (User Experience Questionnaire) [10], a standardized instrument for measuring the pragmatic and hedonic qualities of an interactive product.

### III. PESCAPP

PescApp is a native Android mobile application designed as an integrated management tool for artisanal fishers. Its software architecture follows the Model–View–ViewModel (MVVM) pattern, which separates business logic from the user interface, facilitating scalability and maintenance.

Data is managed through a Firebase NoSQL database, chosen for its ability to synchronize local and cloud storage. This approach enables the app to function offline. At the same time, maintaining data persistence and updating automatically once an internet connection becomes available is an essential requirement for real-world fishing conditions at sea.

We developed the user interface through a stepwise process that began with low-fidelity sketches and evolved into interactive high-fidelity prototypes. The design focuses on a visually clean layout that is easy to use for fishermen with limited technical expertise. The application comprises three functional modules that correspond to the stages of the fishing process: planning, operation (fishing trip), and landing. Each module supports specific tasks that are performed during these stages.

#### A. Planning Module

This module digitizes all preparatory activities carried out before setting sail, replacing manual records and memory with a structured digital system.

1) *Supplies Management*: Allows users to record detailed costs of essential supplies such as fuel, ice, food, and cleaning materials. Each entry includes quantity, unit, description, and price, generating real-time summaries of provisioning expenses (Fig. 2).

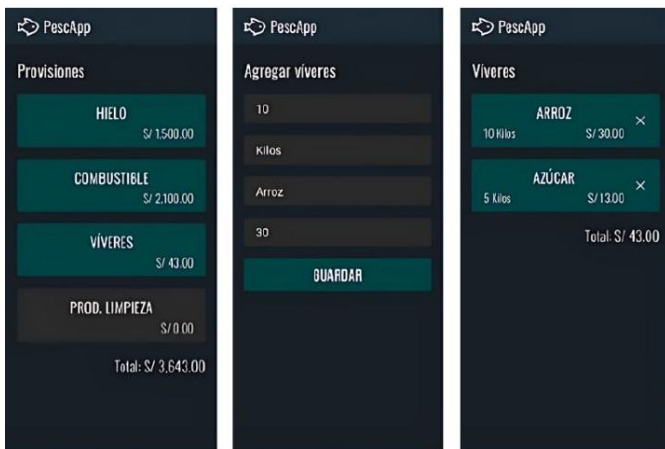


Fig. 2 - Supplies Management Interface.

2) *Crew Management*: Facilitates the registration of crew members, typically three to four per vessel. The system verifies mandatory documentation, such as fishing permits and life insurance, and issues visual alerts when records are incomplete, helping fishers avoid administrative penalties (Fig. 3).

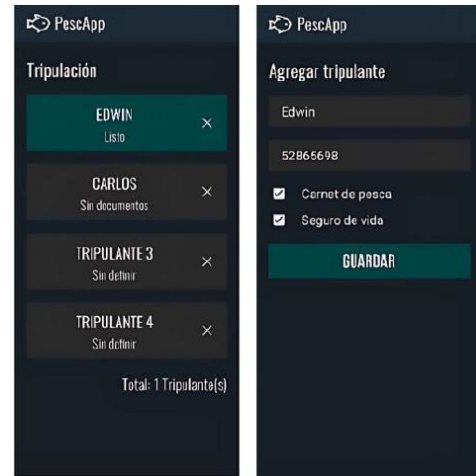


Fig. 3 - Crew Management Interface.

3) *Document and Equipment Checklist*: Provides a digital checklist to ensure that all required permits (fishing license, health authorization, sailing permit) and navigation instruments (compass, GPS, radio, etc.) are on board and operational (Fig. 4).



Fig. 4 - Document and Equipment Interface.

#### B. Fishing Operation Module

This module focuses on providing practical tools for navigation and open-sea fishing.

1) *Itinerary Log*: Using the smartphone's GPS, the application continuously records the vessel's route. It displays key data such as latitude, longitude, speed, and heading on the screen. Most importantly, it allows the fisherman to add markers at specific geographic points to record events, such as "bait catch area" or "fishing spot," and rate the fishing results at that point (Good, Fair, Poor). At the end of the fishing trip, this information can be exported in GPX or KML formats for viewing on maps, creating a digital log of the most productive areas.

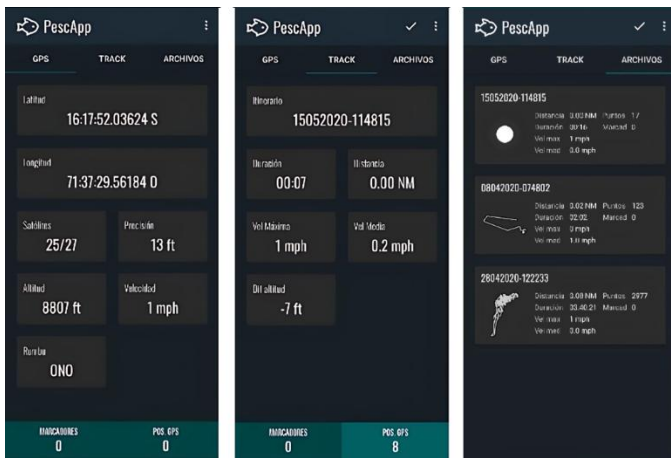


Fig. 5 Trip Registration Interface.

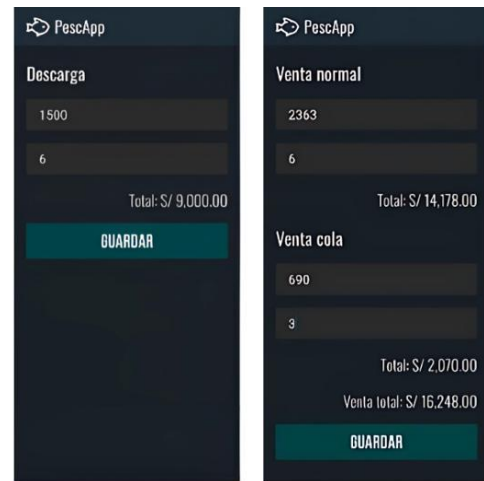


Fig. 7 Expense and Sales Recording Interface.

2) *Operating Guides*: For the case study, the fishermen's association used emerging technologies such as underwater robots (ROVs) to identify schools of fish. To support the adoption of new tech like underwater robots, the application includes visual guides that walk users through loading, deploying, and operating this equipment step by step.

2) *Profitability Calculation*: With all expenses and income recorded, the application performs the final calculation automatically and transparently. It displays a detailed summary that includes:

- **Gross Profit**: Total income minus direct costs.
- **Crew Pay**: Divides the gross profit equally among the crew members, considering an additional fraction for the shipowner.
- **Net Profit**: The remainder for the shipowner, representing the actual profitability of the fishing trip.

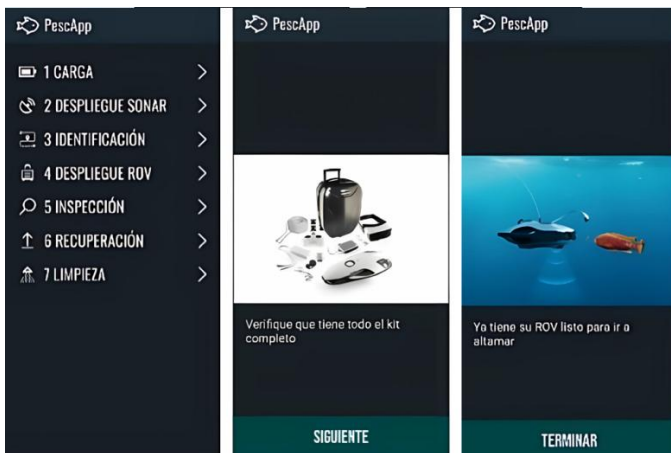


Fig. 6 Operating Guides Interface.

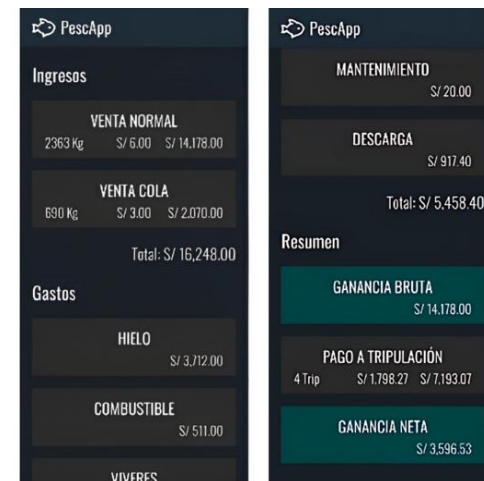


Fig. 8 Profitability Calculation Interface.

### C. Landing Module

This module automates the financial settlement process upon returning to port, a task traditionally performed manually and prone to errors.

1) *Expense and Sales Log*: This feature allows users to record the latest expenses, such as payments to stevedores for unloading the hold. Next, users can record income from the sale of their catch. The application differentiates between two types of sales that reflect market realities: "normal" sales for fish in optimal condition, and "tail" sales for fish that have incurred minor damage (e.g., bruises or tears) or have lost their characteristic coloration, resulting in a lower price per kilogram.

3) *Historical Information Panel*: Beyond the results of a single fishing trip, PescApp offers a control panel with graphs that allow shipowners to analyse their performance over time. It displays the evolution of net profits, the relationship between expenses and income, the volume of fish caught per day per crew member, and variations in the sale price.

This functionality transforms operational data into strategic knowledge, enabling the identification of trends and supporting future planning decisions.

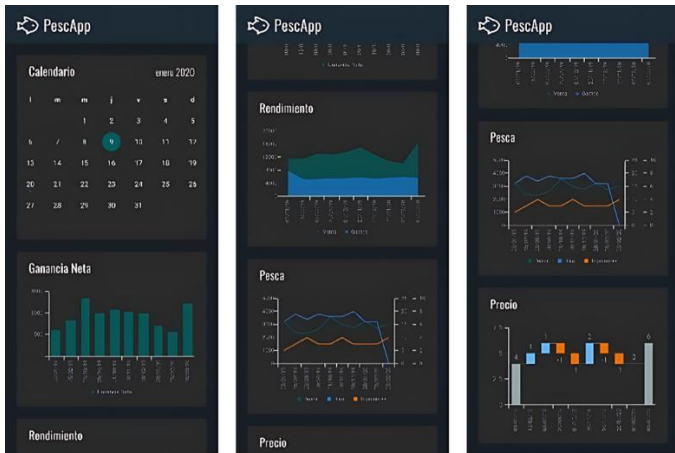


Fig. 9 Historical Information Panel.

#### D. The Expert System

The most innovative feature of PescApp is an expert system designed for real-time decision-making during fishing operations. This system, implemented in CLIPS [11], uses a predefined knowledge base of rules to analyze key variables. The reasoning process is visualized in a decision tree (Fig. 10), which shows the logical sequence for arriving at a recommendation.

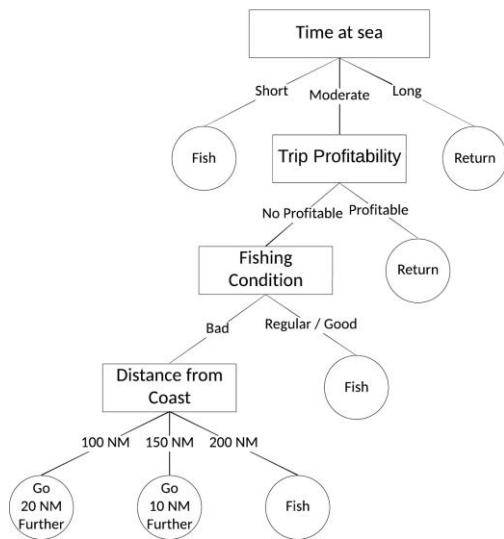


Fig. 10 Expert System Decision Tree.

To complement this view, we used a Mockler diagram (Fig. 11) to identify critical factors and the variables that influence them. This diagram breaks down how concepts such as "Time at sea" or "Profitability" are determined, showing the specific inputs (e.g., number of days, fish price, total expenses) that the system uses for its evaluation

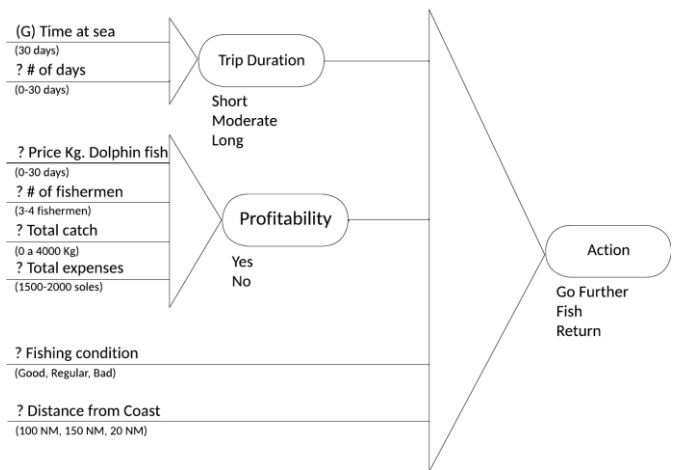


Fig. 11 Mockler's diagram of the critical factors of the expert system.

Based on this data, the system makes a clear and direct recommendation: "Return to port", "Continue fishing," or "Go further out." The decision logic follows a rule hierarchy that mimics the reasoning of an expert fisherman. First, it evaluates the "Time at sea": if it is excessive (close to the supply limit), the immediate recommendation is to return. If the time is short, it suggests continuing fishing. If the time is intermediate, the system evaluates the current "Profitability" of the operation. If the profit is already optimal, it recommends returning to secure the profit. If it is not, the recent "State of fishing" is analysed: if it has been poor, the system suggests a change of location ("Go further out"), but if it has been good or average, the recommendation is to persist in the current area ("Continue fishing").

This transparent process, with recommendations presented to the user in real-time within the application, allows the fisherman to understand the reasoning behind each suggestion. We consciously chose this form of symbolic AI over machine learning models for three strategic reasons, prioritizing suitability for the problem over technological novelty [12]:

- **Explainability (XAI):** Its rule-based logic is 100% transparent. Unlike deep learning "black box" models, the reasoning of the expert system can be audited and understood by the end user, a critical factor in building trust and encouraging technology adoption [13].
- **Viability in Low-Data Environments:** Expert systems operate on encoded expert knowledge, eliminating the need for large volumes of historical data for training, which is non-existent in the context of artisanal fishing in Peru.
- **Offline Efficiency and Operability:** The solution had to be functional in an environment without an internet connection and with the limited resources of a standard smartphone. The CLIPS inference engine is exceptionally lightweight and operates autonomously on the device, ensuring it is operable in real offshore fishing conditions.

#### IV. RESULTS AND DISCUSSION

The validation of PescApp yielded positive results in all phases. Functional tests confirmed the operability of all modules, including GPS recording in real conditions at sea, with accurate route tracking and markers inserted during a voyage of more than 24 km.

The usability assessment (ISO/IEC 25010) highlighted that the application has clear objectives, is easy to learn, and its interface is consistent and aesthetically pleasing for technical users.

The user experience (UX) assessment with the 14 fishermen was the most relevant indicator of the project's success. Using the UEQ questionnaire, PescApp obtained average ratings of 1.821 for Efficiency and 1.571 for Controllability (on a scale of -3 to +3), values considered "Excellent" according to the instrument's data benchmark [10].

This indicates that end users perceive the tool as a means of achieving their goals effortlessly and feeling in control of the interaction.

An important finding is that pragmatic qualities (Efficiency, Transparency, Controllability) were rated significantly higher than hedonic qualities (novelty, stimulation). This underscores that fishermen value the application primarily for its practical usefulness and its ability to solve real problems, rather than for being a technological novelty. This result is crucial, as it suggests that adopting technology in traditional sectors is strongly linked to the perception of tangible, direct benefits [14].

The choice of a simple and explainable AI was therefore a wise decision. By avoiding unnecessary complexity, fishermen were able to use the application and trust its results, thereby fulfilling the objective of creating a handy tool adapted to their reality.

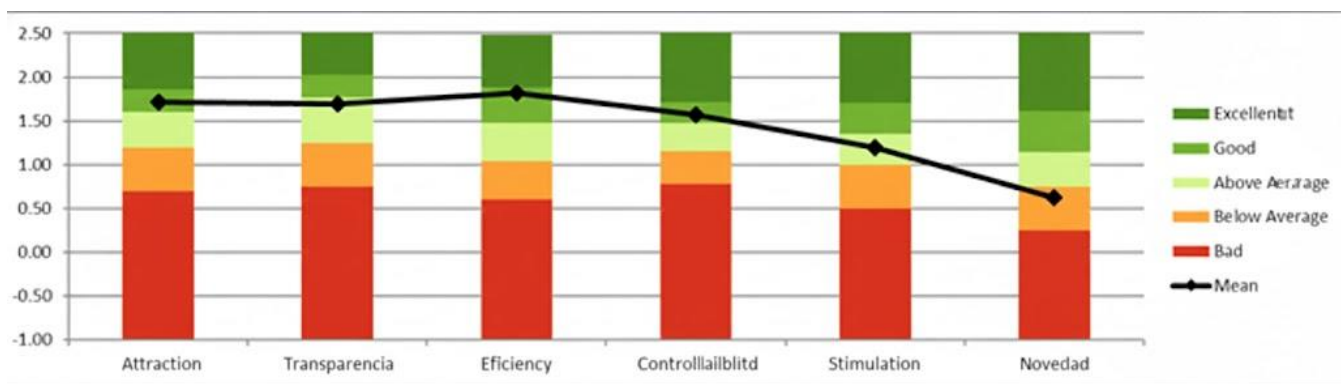


Fig. 12 User Experience Evaluation (UEQ) Results.

#### V. CONCLUSIONS

The development and validation of PescApp demonstrates that it is possible to create practical, high-impact technological tools for traditionally underserved sectors such as artisanal fishing. The mobile application prototype successfully fulfills its objective of supporting operational management, allowing greater control over the costs and profitability of fishing operations. The success of the project rests on two fundamental pillars:

- A collaborative design process that involved fishermen from the beginning, ensuring that the final solution aligned with their workflows and actual needs.
- A practical approach to innovation, choosing the technology (including AI) that effectively addresses the problem in its specific context. This approach prioritizes usability, explainability, and trust over unnecessary technical complexity.

This case study showcases applied innovation, with clear potential to scale up and significantly contribute to the economic development, formalization, and sustainability of the artisanal fishing sector in the region and the country.

#### ACKNOWLEDGEMENT

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