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Bangus (Chanos Chanos) Fry Counter

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Abstract: ***Agriculture has a key role in the Philippines economy, particularly the fisheries industry, which contributes 15% of the country's overall income. The sector offers significant employment and income opportunities for various parts of the population, contributes to export earnings, and meets a substantial portion of the population's protein nutritional requirements. In terms of employment, the fisheries sector employs over one million people, accounting for approximately 5% of the nation's workforce. The general objective of the study is to develop a portable bangus fry counter for the University of Antique – Hamtic Campus, Hamtic, Antique, and to create an affordable fry counter for local fish fry vendors, fish pond owners, and others who can benefit from this thesis. The researchers used the Arduino as the operating system, the light sensor for input, and the LCD for output. For data gathering, the researchers used the ISO 25010 characteristic, the weighted mean formula to calculate the mean, and the Likert scale. The prototype demonstrated excellent performance in counting the quantities of bangus fry. Based on the evaluation results, the participants strongly agreed with the device's functionality, reliability, portability, maintainability, security, compatibility, performance efficiency, and usability.***

Keywords: Fry Counter, Bangus, Chanos Chanos,

I. INTRODUCTION

Aquaculture is a significant source of income and food, particularly in developing countries. Milkfish, tilapia, shrimp, seaweed, oyster, mussel and carp are common aquaculture species [1]. Due to their excellent nutritional content, aquatic products are gaining popularity. Recent breakthroughs in aquaculture technology have led to significant improvements in aquaculture operations, resulting in the development of new techniques, particularly in intensive aquaculture and systems in natural waters. Lack of technology, on the other hand, will have an impact on the future expansion of the Philippine aquaculture in various areas. The stocking of fry is the first step in fish farming, a key component of aquaculture. In aquaculture, counting milkfish fry is a regular difficulty [2]. The majority of farmers count their fish using a manual method, which is time-consuming and prone to errors. Aquarists who use a milkfish fry counting system, on the other hand, may count their fish with significantly better accuracy and speed.

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Milkfish fry counting systems are sophisticated computerised systems that leverage developments in sensor technology to automatically detect and count the fry without the use of human hands. Object counting in aquaculture is a crucial task that has been widely applied in estimating fish population, determining lobster abundance, and assessing scallop stocks, among other uses. However, underwater object counting is challenging for biologists and marine scientists because of the diversity of backgrounds of the lake or ocean, the uncertainty of the object motion, and the occlusion between objects [3].

At present, there are three ways to count fish in the aquaculture industry. The first method is auditory, utilising an acoustic camera. In this method, the image resolution deteriorates, making it unsuitable for counting large numbers of individual fish in aquaculture farming. The second method involves checking for an alteration in electric potential by placing an electrode under water, known as a fish counter. It has been used to estimate the regression rate of Atlantic salmon (Salmo salar) in Western countries. It is said that in Japan, some researchers have also tried to verify this method. For implementing this technique, it is necessary to position the sensor in a specific fishway to detect the fish. This makes it difficult to count the number of individuals in general farm cages. The third is video analysis. Some techniques use image processing to extract the foreground, and then apply a machine learning algorithm like a neural network to identify each fish [4].

With the increasing popularity and overview of the concept of marine ranching, the offshore aquaculture industry has experienced rapid development in recent years. The precise counting of fish stocks provides the basis for effective management of scientific fishing, sale, transportation, and control of breeding density. The traditional counting method uses containers like a net bag to sample, which brings lots of disadvantages like low efficiency, limited artificial experience and so on [5].

Fish counting is an open problem in real-world environments. It is a priority necessity in aquaculture farming, where the fish count must be performed quickly and reliably for marine species during growth and at various stages of production. On the one hand, knowing the number of species under cultivation helps to provide the optimum conditions during the cultivation environment, thus guaranteeing the health and growth of the species and the proper inventory of the developed production at the established ranges [6]. Also, the calculation of catfish seeds is done conventionally, by sorting the size of catfish seeds using a hollow tub and then manually calculating the number of seeds [7].

It is in this notion that the researchers were eager to conduct such a study and test the feasibility and efficiency of the fry counter.

II. RESEARCH OBJECTIVES:

General Objective:
The general objective of the study was to develop a portable bangus fry counter for the University of Antique – Hamtic Campus, Hamtic, Antique.
Specific Objectives:
Specifically, this study sought to:

1. Implement a low-cost and portable bangus fry counting machine that can precisely and automatically count a large number of bangus fry.
2. Develop a bangus fry counter system using the Arduino microcontroller as the operating platform, and
3. Test the quality of the developed system characteristics using ISO 25010 standards.

III. METHODOLOGY

A. Research Design

The researchers applied the developmental research methodologies to achieve the study's goal. This is a fact-finding procedure that comprises a thorough and accurate review of data and findings. The research was divided into multiple iterative phases: analysis, design, development, implementation, and evaluation. The results of a descriptive survey provided a foundation for identifying potential impacts that could help address practical problems.

B. Participants of the Study

The research was conducted at the University of Antique – Hamtic Campus, Guintas, Hamtic, Antique. To test the device's accuracy rate and efficiency, the researchers randomly selected 35 participants from the BS Computer Science and BS Agriculture faculties, as well as staff, students, and fishermen in Guintas, Hamtic, Antique.

C. Data Gathering Instruments and Techniques

The ISO 25010 evaluation questionnaires were used as the primary tool to collect data. The questionnaire consists of a sequence of questions based on the ISO 25010 characteristics.

D. Preparation of Instruments

The data collection was the most critical aspect of this investigation. To develop the study's concept and data, the researchers prepared structured questions based on the characteristics of ISO 25010 for the instruments.

a. Validation of Instruments

The ISO standard questionnaire was used in the study.

b. Data Gathering Procedure

During the data collection, the researchers individually gave the questionnaire to the participants. First, the researchers distributed the questionnaire to the 35 randomly selected participants. Next, the questionnaires were gathered successfully. Finally, the researchers began to interpret the results from the collected questionnaires.

c. Statistical Tools

Weighted mean-formula

The weighted mean for each item was calculated by multiplying the scale value of the responses by the total number of responses to obtain the weighted mean for each item. The central tendency is measured by the mean. It indicates where the majority of the responses to a question cluster.

Where:

$$x = \frac{\Sigma fx}{n}$$

X = Weighted Mean

F = Frequency

X = Scores

n = Total number of participants

Σ = Summation symbol

d. Likert Scale

The researchers used the Likert Scale method to evaluate the weighted Mean (WM) using the following interval meanings. For the suggested Bangus Fry Counter, this 5-point scale was utilized to calculate the rank or adjectival description of the weighted mean of the responses. For each rating, the fields represent the rating, its corresponding range, and an adjectival description. These ratings are:

Table 1. Likert Scale with Range

Interpretation	Value	Range
Poor	1	1.00 - 1.79
Fair	2	1.80 - 2.59
Good	3	2.60 – 3.39
Very Good	4	3.40 – 4.19
Excellent	5	4.20 – 5.00

Table 1 shows the Likert Scale of the weighted mean. The weight is categorised into five weighted points. The range for the 5-point scale is shown in the table.

E. Ranking

This was used to calculate the rank average for each answer's choice and determine the highest and lowest ranks based on the results.

a. Context Diagram

The diagram used is shown below.

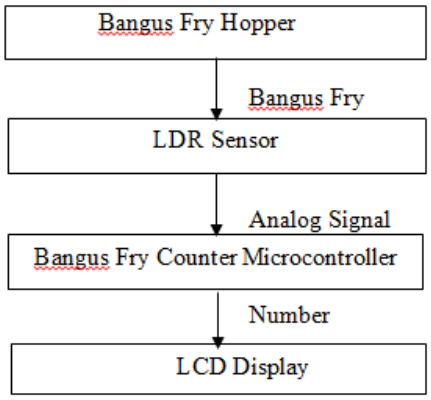

Figure 1. Context Diagram of Bangus Fry Counter

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F. Data Flow Diagram

The graphical representation of the flow of the data that was used.

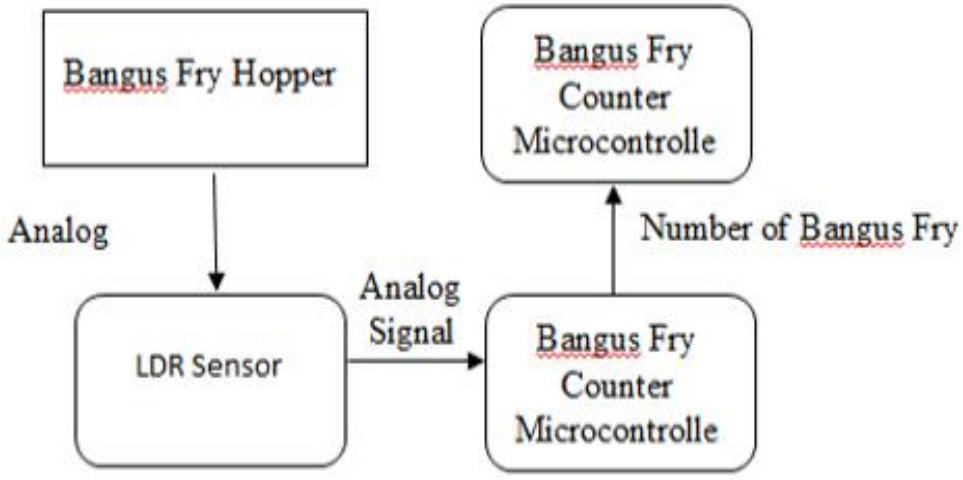


Figure 2. Data Flow Diagram of Bangus Fry Counter

G. Use case Diagram

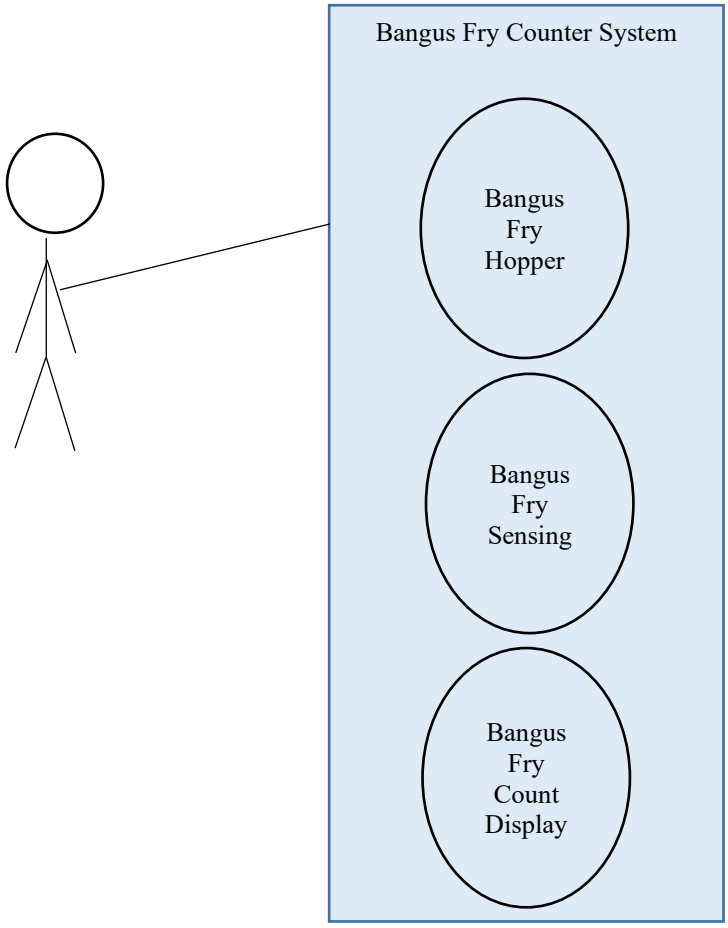
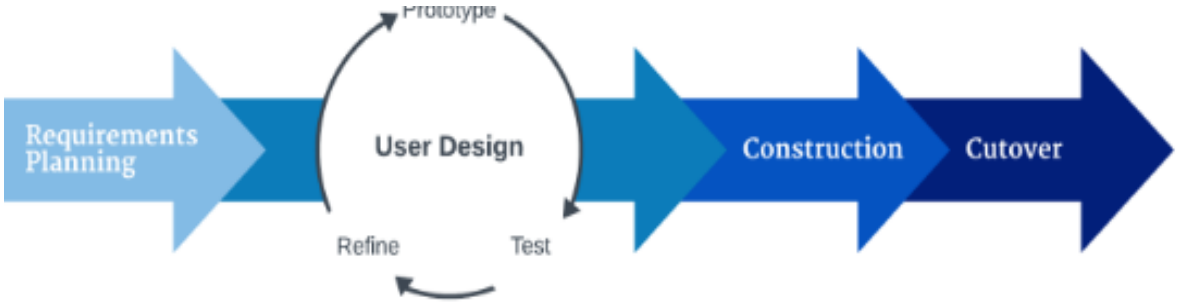


Figure 3. Use Case Diagram of the Fry Counter

The figure below shows the process of Rapid Application Development: (1) Requirements Planning, (2) User. Design, (3) Construction, and (4) Cutover



https://kissflow.com/application-development/rad/features-of-rapid-application-development-software/

Figure 4. RAD (Rapid Application Development) Model

Rapid Application Development 9RAD) is a team-based technique for accelerating the development of information systems and producing a working system. Like Joint Application Development (JAD), RAD takes a collective approach but takes it a step further. While JAD's final outcome is a requirement model. RAD's final product is a new information system. RAD is a comprehensive approach comprising four phases that align with the Systems Development Life Cycle (SDLC) phases. Companies utilise RAD to minimise development costs and time, while increasing the likelihood of success.

IV. RESULTS AND DISCUSSION

The researchers employed the Rapid Application Development (RAD) model for developing a system that requires a highly interactive or complex user interface, due to its comprehensive methodology that relies on prototyping and user involvement in every phase. This approach helps reduce development costs and time while increasing the likelihood of success.

Table 2. Mean Distribution of functional suitability of the Bangus (Chanos Chanos) Fry Counter

Functional suitability	Mean	Std. Deviation	Range
Completeness	4.51	0.50	Excellent
Correctness	4.43	0.55	Excellent
Appropriateness	4.49	0.60	Excellent

Note: Mean is described as follows: 5.0-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80.59 Fair; 1.00-1.79 Poor

Table 2 presents the mean distribution of the system's functional suitability, based on its completeness, correctness, and appropriateness. Based on the results, the participants of the study interpreted and described the functional suitability of the bangus (Chanos chanos) Fry Counter as "excellent" in terms of completeness and correctness, with computed means of 4.51 (SD = 0.50), 4.43 (SD = 0.50), and 4.9 (SD = 0.60), respectively.

Table 3. Mean Distribution of Reliability of the Bangus (Chanos Chanos) Fry Counter

Reliability	Mean	Std. Deviation	Interpretation
Maturity	4.51	0.55	Excellent
Availability	4.49	0.60	Excellent
Fault Tolerance	4.46	0.60	Excellent
Recoverability	4.51	0.69	Excellent

Note: Mean is described as follows: 5.0-4.20 Excellent; 3.20-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

Reflected in Table 3 is the mean distribution of reliability of the system based on maturity, availability, fault tolerance and recoverability. Based on the result, the participants of the study interpreted and described the Reliability of the Bangus (Chanos Chanos) Fry Counter as "excellent" in terms of maturity, availability, fault and tolerance and recoverability with mean of 4.51 (SD=0.55), 4.49 (SD=0.60), 4.46 (SD=0.60) and 4.52 (SD=0.69).

Table 4. Mean Distribution of Portability of the Bangus (Chanos Chanos) Fry Counter

Portability	Mean	Std. Deviation	Description
Adaptability	4.46	0.69	Excellent
Durability	4.46	0.55	Excellent
Instability	4.49	0.60	Excellent
Replaceability	4.31	0.57	Excellent
Affordability	4.43	0.65	Excellent

Note: Mean is described as follows: 5.0-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

Table 4 presents the mean distribution of system portability based on adaptability, durability, instability, replaceability, and affordability. Based on the Bangus (Chanos Chanos) Fry Counter as "excellent" in terms of adaptability, durability, instability, replaceability and affordability with a mean of 4.46 (SD=0.69), 4.46 (SD=0.55), 4.49 (SD=0.60), 4.31 (SD=0.57) and 4.33 (SD=0.65), respectively.

Table 5. Mean Distribution of Usability of the Bangus (Chanos Chanos) Fry Counter

Usability	Mean	Std. Deviation	Description
Appropriateness Recognizability	4.6	0.55	Excellent
Learnability	4.43	0.55	Excellent
Operability	4.49	0.60	Excellent
User Error Protection	4.4	0.64	Excellent
User Interaction Aesthetics	4.6	0.55	Excellent
Accessibility	4.51	0.65	Excellent

Note: Mean is described as follows: 5.0-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

The data in Table 5 shows the mean distribution of system usability based on appropriateness, recognizability, learnability, operability, user error protection, user interaction aesthetics, and accessibility.

Based on the result the participants of the study interpreted and described the Usability of Bangus (Chanos Chanos) Fry Counter as "excellent" in terms of appropriateness recognizability, learnability, operability, user error protection, user interaction aesthetics and accessibility with mean of 4.6 (SD=0.55), 4.490 (SD=0.60), 4.4 (SD=0.64), 4.6 (SD=0.55), 4.51 (SD=0.65) respectively.

Table 6. Mean Distribution of Performance Efficiency of the Bangus (Chanos Chanos) Fry Counter

Performance Efficiency	Mean	Std. Deviation	Description
Time Behavior	4.51	0.55	Excellent
Resource Utilization	4.51	0.55	Excellent
Capacity	4.43	0.65	Excellent

Note: Mean is described as follows: 5.00-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

Table 6 presents the mean distribution of system performance efficiency based on time behaviour, resource utilisation, and capacity. Based on the results, the participants of the study interpreted and described the Performance Efficiency of the Bangus (Chanos chanos) Fry counter as "excellent" in terms of time behaviour, resource utilisation, and capacity, with means of 4.51 (SD = 0.55), 4.51 (SD = 0.55), and 4.51 (SD = 0.65), respectively.

Table 7. Mean Distribution of Security of the Bangus (Chanos Chanos) Fry Counter

Security	Mean	Std. Deviation	Description
Confidentially	4.54	0.55	Excellent
Integrity	4.49	0.65	Excellent
Non-repudiation	4.57	0.49	Excellent
Accountability	4.49	0.65	Excellent
Authenticity	4.49	0.55	Excellent

Note: Mean is described as follows: 5.00-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

Table 7 shows the mean distribution of system security based on confidentiality, integrity, non-repudiation, accountability, and authenticity. Based on the result, the participants of the study interpreted and described the Security of the Bangus (Chanos Chanos) Fry Counter as "excellent" in terms of confidentially, integrity, non-repudiation, accountability and authenticity with mean of 4.49 (SD=0.65), 4. 57 (SD=0.49), 4.49 (SD=0.65), and 4.49 (SD=0.55) respectively.

Table 8. Mean Distribution of Compatibility of the Bangus (Chanos Chanos) Fry Counter

Compatibility	Mean	Std. Deviation	Description
Co-existence	4.51	0.55	Excellent
Interoperability	4.37	0.64	Excellent

Note: Mean is described as follows: 5.00-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

Table 8 presents the mean distribution of system compatibility based on coexistence and interoperability. Based on the study's results, the participants interpreted and described the Compatibility of the Bangus (Chanos chanos) Fry Counter as "excellent" in terms of coexistence and interoperability, with means of 4.51 (SD = 0.55) and 4.37 (SD = 0.64), respectively.

Table 9. Mean Distribution of Maintainability of the Bangus (Chanos Chanos) Fry Counter

Maintainability	Mean	Std. Deviation	Description
Modularity	4.63	0.48	Excellent
Reusability	4.43	0.69	Excellent
Analyzability	4.63	0.48	Excellent
Modifiability	4.49	0.70	Excellent
Testability	4.54	0.60	Excellent

Note: Mean is described as follows: 5.00-4.20 Excellent; 3.40-4.19 Very Good; 2.60-3.39 Good; 1.80-2.59 Fair; 1.00-1.79 Poor

Table 9 presents the mean distribution of system maintainability based on modularity, reusability, analyzability, modifiability, and testability. Based on the result, the participants of the study interpreted and described the Maintainability of the Bangus (Chanos Chanos) Fry Counter as "excellent" in terms of modularity, reusability, analyzability, modifiability and testability with mean of 4.63 (SD=0.48), 4.43 (SD=0.69), 4.63 (SD=0.48), 4.49 (SD=0.70), and 4.54 (SD=0.60) respectively.

V. SUMMARY AND CONCLUSIONS

A. Summary

The primary objective of the study was to develop a portable Bangus Fry Counter for the University of Antique-Hamtic Campus. The university and its students can benefit from having access to a low-cost bangus fry counting device that can be utilised in laboratory activities. To achieve those objectives, the researchers gathered relevant data through interviews with personnel, faculty, and students of the University of Antique-Hamtic Campus, as well as from new online articles and current devices related to the topic. Survey forms were also distributed and collected from the participants after the initial development and final testing. The results were compiled from the tables presented, and it was demonstrated that the researchers' objectives were met.

VI. CONCLUSIONS

After thoroughly analysing and evaluating the data gathered from participants through initial testing and their evaluation, the researchers drew the following conclusions: The prototype demonstrated excellent performance in terms of counting fry quantities. Based on the evaluation results, the participants strongly agreed with the device's functionality, reliability, portability, maintainability, security, compatibility, performance efficiency, and usability. It was also determined that the bangus fry counter, which was designed with low-cost and easily accessible technology, can be manufactured and used to lower the margin of error in experiments that require large-scale human counts of bangus fry, thereby optimising the process.

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Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	All authors have equal contributions to this article.

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AUTHOR PROFILE

Dr. John C. Amar, a native of Malabor, Tibiao, Antique. He graduated is secondary education at the University of Antique, Tario-Lim Memorial Campus, Tibiao, Antique. He finished his Bachelor of Science in Computer Science at the same University. He earned his Master of Education degree at the same University. Very eager to earn his Doctoral Degree, he pursued a Doctor of Management degree at Central Philippine University (CPU), Jaro, Iloilo City. Then, in 2017, he earned a Master of Science in Computer Science (MSCS) from AMA Computer University, completing it in 2020.

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