MICROCONTROLLER-DRIVEN FEEDING MANAGEMENT AND AUTOMATION FOR L. VANNAMEI SHRIMP AQUACULTURE

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APPROVAL SHEET

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ARTICLE 1:

Microcontroller-driven Feeding Management and Automation for *L. vannamei* Shrimp Aquaculture

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Abstract— **Shrimp is highly valued in the seafood industry by many people worldwide. This study aims to properly designate the correct amount of shrimp feed based on sampling the shrimp farm in proportion to the age and weight of the L. *vannamei* and deploy a system that will automate the proper feed distribution through the integration of microcontrollers. This study also includes a pond monitoring system to ensure that the pond's water quality is adequate for the shrimp's cultivated health and development. The researchers compare shrimp development in culture ponds using an automated feeder and a manual feeding approach to determine the efficiency or effectiveness of the computerized feeder for managing feeds. The growth analysis is divided into two ponds (1 and 2). For measuring shrimp development, the automated feeder favored pond 1, whereas pond 2 for manual feeding. This study found that utilizing an auto feeder increased shrimp growth rates by ensuring they were adequately fed based on the average body weight of shrimp every sampling and made them healthier by using sensors to monitor the pond's water quality. The researchers successfully developed the automated feeder and tested it many times, obtaining a total accuracy of 96.21%.**

Index Terms— **Feeding Management, Automation, Automated Feeder, Microcontroller-driven Feeding Management, Automatic Feeder with Pond Monitoring System**

I. INTRODUCTION

Since shrimp aquaculture began in the Philippines in the 1980s, the Philippines has become one of Asia's leading shrimp producers. In December 2013, the Philippines' Bureau of Fisheries and Aquatic Resources (BFAR) registered 271 brackish water shrimp farms (with a total area of 3,617.8 ha) [1].

Penaeus monodon (Tiger Prawn) and L. vannamei (Pacific White Shrimp) are the two most common farmed shrimp varieties. Penaeus monodon, also known as P. monodon, is grown in 48 percent (1,772.6 ha) of the country's shrimp farms. The L. vannamei is cultivated on 27% (909.4 ha) of shrimp farms, while other shrimp varieties, including the Endeavor shrimp, are grown on the remaining 25% (935.8 ha). Due to the difficulties of raising P. monodon, farmers have shown an interest in cultivating pacific white shrimp. Disease issues have afflicted the P. Monodon culture, and farmers have had trouble finding pathogen-free seeds. Rising feed and electricity prices are also issues. Because of its resistance to specific diseases, low nutrient demand, and competitive rates in the domestic market, the species L. vannamei is attractively marketable [2].

Due to its higher growth rate of 1.0 to 1.5 grams (g) per week relative to P. monodon's growth rate of 1 g/week, many farmers in the Philippines are now choosing L. vannamei over P. monodon. L. vannamei shrimp are often more standardized in size at harvest, eliminating the need for sorting before distribution to the market [3]. Several factors, such as the harvest ton, mean body weight, survival rate, and feed conversion ratio, can all be used to quantify shrimp growth and production. According to previous research, the shrimp feed conversion ratio should be proportional to their mean body weight [4]. This variety of shrimp also consumes feed regardless of light and dark conditions, according to research that looked at the feeding pattern of L. vannamei [5]. Floods, typhoons, and monsoon rains may all significantly impact shrimp farming. Shrimp development has slowed, disease resistance has increased, and mass fatality has occurred because of pollution from watershed activities and self-generated organic load [6]. The shrimp aquaculture industry depends upon the proper feeding and harvesting techniques. The first step in appropriate feed management at the farm level is choosing and buying a feed that will expand production under the cultivated shrimps [7]. Traditionally, the shrimp needs to feed 1-4 times a day. Still, the advent of automated feeders has enabled farmers to increase the number of feedings without raising the labor needed [8]. However, Ullman et al. (2018) presented that feeding six times compared to 2 times increased significantly. Theoretically, increased feeding frequency results in higher nutritional feed content because nutrient leaching is reduced [9].

The nutritional performance of a shrimp feed depends upon five interconnected factors, namely: the nutrient content and composition of the diet fed, the physical properties and water stability of the diet provided, the transportation and storage of the diet before giving feed on the farm, the feeding method employed for feed application and usage on the farm; and the farming system, stocking density, water management, and availability of natural foods [10]. Shrimp feeding is essential to avoid losing profits due to the high cost of shrimp feeds. It can minimize feed cost in L. vannamei culture. The feed conversion ratio would be low for the duration of cultivation by appropriately implementing the prescribed feeding guide and selecting the proper feed to utilize. However, the variability in behavior and feeding patterns of shrimp raised in shrimp culture ponds is still poorly known. Adopting good feed management practices will help to reduce water quality problems and increase shrimp production success. Diets are used in semi-intensive cultures to boost production beyond the pond's natural productivity standards, which can take up to 85 percent of the shrimp's diet. However, it's crucial to specify how feeding rates affect survival, weight gain, growth, productivity per hectare, and the total biomass [11]. According to Fox et al. (2001), The farmer will apply the feed regularly and only in the amount consumed rapidly to maximize growth and minimize waste. Historically, farmers applied the feed; consumption tracked using manual labor to spread and inspect feeding trays [12]. Automatic feeders are becoming more popular because of their ability to provide more feedings per day while requiring less labor than manual feeding [13]. Another advancement is using hydrophones to track the shrimp's feeding response in the pond to assess the feeding activity and then provide based on that response [14]. All these technological advancements can benefit both productivity and water quality.

This study aims to properly designate the correct amount of shrimp feed based on sampling the shrimp farm in proportion to the age and weight of the L. *vannamei* and deploy a system that will automate the proper feed distribution through the integration of microcontrollers. It also includes a pond monitoring system to ensure that the ponds' water quality is adequate for the shrimp's health and development while cultivating.

This application will help the shrimp industry of the Philippines to maintain the ranks of worldwide shrimp aquaculture by helping shrimp farmers be more efficient and technologically precise through accumulated data of feeding practice. This study will reduce the cost of cultivating shrimp farms by ensuring that overfeeding, feeding waste, and water and soil quality deterioration will not improve shrimp development. This new project will be a milestone in technology and aquaculture. This study would become an excellent reference for future computer engineers dealing with the fusion of aquaculture and technology.

For this study, the preferred feed for L. *vannamei* is Blanca Vannamei Feeds from Charoen Pokphand. Foods Philippines Corporation. The meal provides precise essential amino acids, vitamins, minerals, and other vital nutrients for optimum growth and enhanced immunity against stress. This preferred feed is according to the product guide given by manufacturers [15].

The extent of this research covers the classification of the current weight and age of the shrimps in correlation to the correct feeding guide of the preferred brand by local farmers. This research also covers the automation of the feeding process but not in real-time. This system is a prototype and will not be industrial-sized. The stocking of feed will be done manually and not include the harvesting process.

II. MATERIALS AND METHODS

For this study, applied research is an outline for the whole duration. It aims to develop a system that will determine the correct amount of shrimp feed and automate the feeding process via microcontroller data comparison and manipulation.

For the development of the system, knowledge in circuitry, electronics, and microcontroller programming is involved.

A. Conceptual Framework

Fig. 1 shows the conceptual framework of the study. The input is the weight of the shrimp concerning the age of the shrimp. It will undergo the process of the pond monitoring system that determines the water temperature, pH acidity, and water level of the pond. Determining the feed amount and feeding schedule based on the input and conditions of the software. These processes will yield a system that automates proper feed distribution.

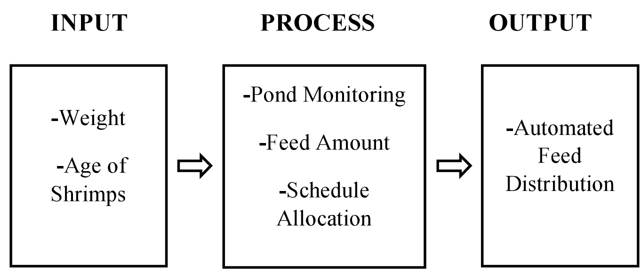

Fig. 1 Conceptual Framework

B. Material and Resources

The design involved three parts of the mechanical system: the shrimp feeds container, automated supporting system, and disseminator—the shrimp feed container designed with two parts. The first part is the container attached to the second part (mechanical supportive system). Fig. 2 shows the whole system.

The shrimp feed container is made of a steel plate 0.8 mm thick, 12 x 10 inches in width, and 17 inches in height. The feed container can have 2 kg feeds in it. The researchers used Visual Studio software to design the research's user interface, and a series of codes will be implemented using the VB.NET language. All codes from the pond monitoring system to an automated feeder will be coded separately to quickly detect software errors when debugging and troubleshooting. The proponents built the device with a steel container with an acrylic glass design to ensure good feed storage. The feed's vitamins, minerals, and other essential nutrients will not be degraded and help deter birds and pests.

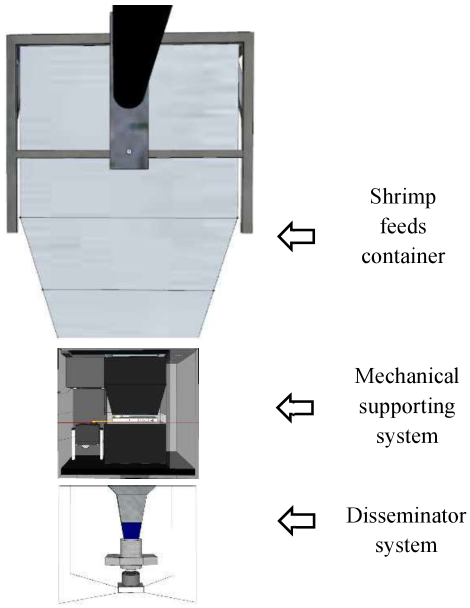

Fig. 2 Feeds Container and Disseminator System

The mechanical supporting system is divided into two parts. The first part is the first servo motor that holds the plate to control the feeds going to the second part. The second part is the second servo motor that carries the load cell to manage the number of meals before disseminating. Fig. 3 shows the mechanical supporting system attached to the bottom part of the container.

The researchers installed CZL639HD loadcell to properly weigh the feeds given to the shrimps in time of feeding based on the average body weight of every sampling.

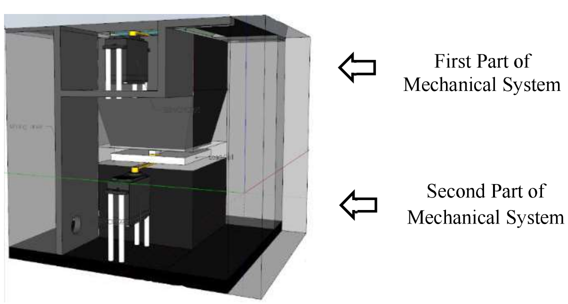

Fig. 3 Inside the Mechanical Supporting System

To install the automated feeder in the L. vannamei pond needs a supporting system. All mechanical systems shown in Fig. 2 are attached to the support system shown in Fig. 4.

The supporting system has two poles. The first pole is about 19.6 ft (6m) long and is buried about 6 ft (2m) in the ground, while the second pole that holds the feed container is about 6 meters long. The circuits were placed in the small box beside the system unit for the pond monitoring. The automated feeder is connected and will work using the laptop and the program installed in the software. The 5 volts dc motor speed can be controlled by manipulating the 5 volts two-channel relay installed in the Arduino Mega, and it is operated from 0 up to 1,000 rpm. With this variable speed, the distance of feed throwing can cover all the vital areas of the pond.

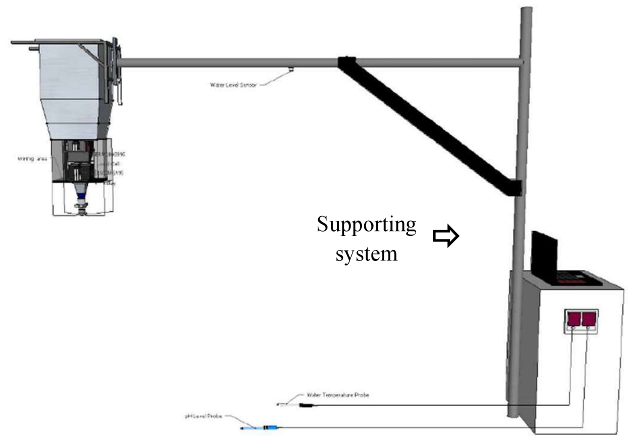

Fig. 4 Feeds Container, Disseminator, and Its Support

The software system also continuously determines the pond's water temperature, pH acidity, and water level using the Arduino Uno placed inside the box. For water temperature, the system utilized a DS18B20 sensor, Arduino pH sensor for pH acidity, and ultrasonic sensor for water level; near the supporting system of the device placed the package. The system block diagram for monitoring the shrimp production habitat's water quality is shown in Fig. 5.

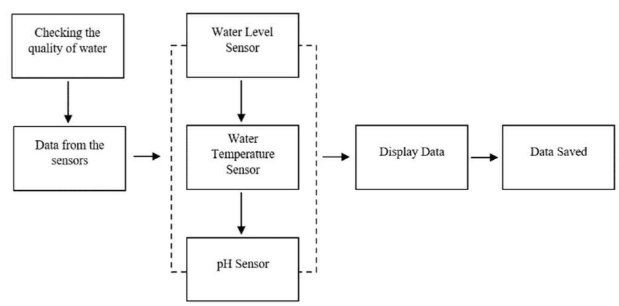

Fig. 5 Block Diagram of Pond Monitoring

C. System Flow

First, a sample L. *vannamei* shrimp will be weighed. After the weight is determined, the system will cross-reference it with the feeding guide and the cycle schedule of the aquaculture. The flow will result in getting the precise feed amount and schedule. After this, the automatic feeding process will commence by the program using the manipulation of the microcontrollers and relays to control the mechanical part of the system. Then the system will display the current activity status of the feeder. It will also prompt for feed. Stock refill when necessary. Fig. 6

below illustrates the system's flow to accomplish the study's objectives.

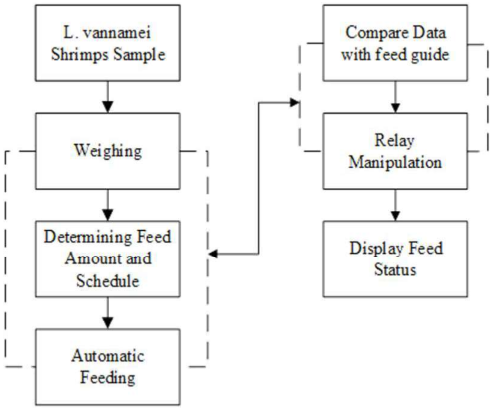

Fig. 6 Device System Flow

The research object was created using tools made with an Arduino Uno and equipped with a temperature sensor to measure pond water temperature, a pH sensor to measure pH balance, and a 0-100g loadcell to determine the weight of the shrimps to be sampled. The automatic feeder connects to the Arduino Mega, equipped with an ultrasonic sensor to measure water level and a 0-100g to determine feed weight. Fig. 7 below illustrates the flow of the hardware system.

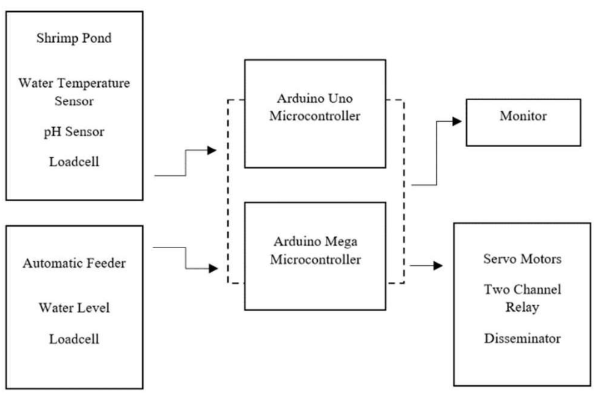

Fig. 7 Block Diagram of the Hardware System

II. RESULTS AND DISCUSSIONS

Fig. 8 below shows the actual design of the device wherein the connections of the main components are inside the hardware. The automated feeder comprises three MG 995 servomotors, a load cell, and a dc motor connected to an Arduino Mega placed on the left side of the mechanical supporting system. It also includes the device's supportive system and Arduino Uno for pond monitoring located inside the box. A laptop displays the output of the pond monitoring sensors and the feeding process status when an automated feeder is in use. The pond monitoring sensors, which consist of a DS18B20 water temperature sensor, Arduino pH sensor/meter kit, and an Arduino ultrasonic, are used to monitor the pond's water quality to ensure shrimp's health and development while being cultivated.

Fig. 8 Actual Design of the study

The researchers compare shrimp development in culture ponds using an automated feeder and a manual feeding approach to determine the efficiency or effectiveness of the computerized feeder for managing the feeds. The experiment was conducted at Kitagas, Sarangani Province, from May 22, 2021, to July 31, 2021. The growth analysis is divided into two ponds (1 and 2). Pond 1 measures shrimp development using an automated feeder, whereas pond 2 uses manual feeding.

Water quality parameters in the culture ponds are shown in Fig. 9. The system device will automatically record the water level, water temperature, and pH value for the water quality of both ponds every after seven days. The pond water temperatures ranged between 27—83 °C and 32.19 °C. The pH value of both ponds ranged between 7.51 and 8.19.

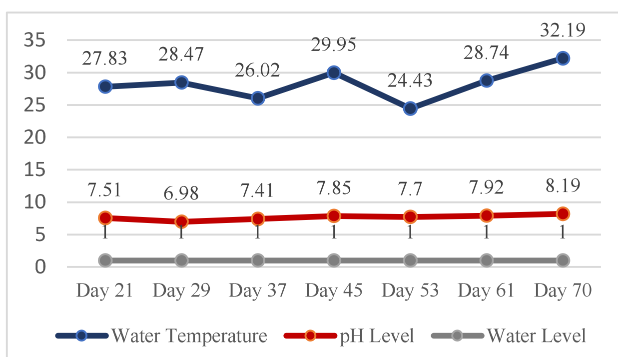

Fig. 9 Water Quality of 2 ponds during the culture period (May-July 2021)

Fig. 10 below shows the number of shrimps that survived by the stocking population. The researchers determined the total number of mortalities for the automated pond and manual pond after 70 days of cultivation. Out of 200 pcs, the number of shrimps survived in automatic feeding is 177, while manual feeding is 135.

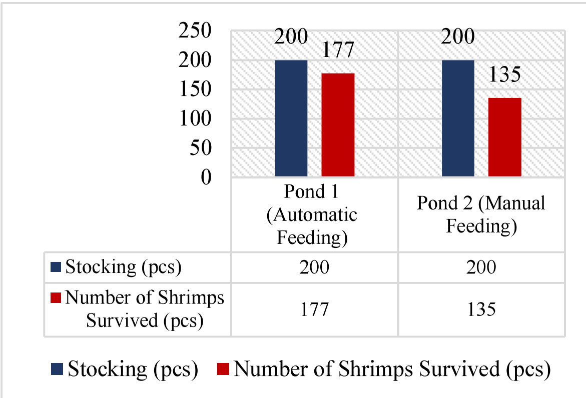

Fig. 10 The Graph of Number of Shrimps Survived about the Shrimp Population

Fig. 11 below shows the natural survival rate for automated feeding, which is 88.5%, with a total mortality rate of 11.5% compared to the survival rate for manual feeding is 67.5%, which has a real mortality rate of 32.5%. Pond 1 had a 21% better survival rate compared to pond 2.

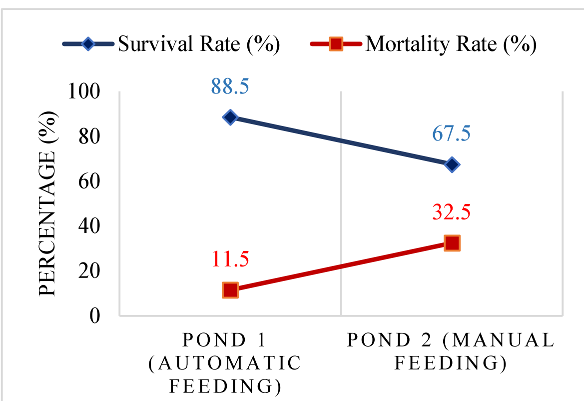

Fig. 11 The Graph for Survival Rate and Mortality Rate

The outcomes of shrimp development achieved throughout the culture period are detailed in (Table 1). Regardless of the feeding period, greater feed levels improved average body weight, survival, biomass, and production output. The automatic feeder utilized pond demonstrated higher average body weight growth after 70 days of cultivation, although the FCR was very good compared to the manual feeding pond.

Table 1: Detailed Outcomes During Culture Period.

Parameters	**Pond 1 (Automatic Feeder)**	**Pond 2 (Manual Feeding)**
Area (m)	2 x 2.5	2 x 2.5
Stocking (pcs)	200	200
Stocking Date	May 22, 2021	May 22, 2021
Harvest Date	July 31, 2021	July 31, 2021
Culture Period (d)	70	70
Average Body Weight (g)	20.01	19.96
Number of Shrimps Survived (pcs)	177	135
Survival Rate (%)	88.5	67.5
Mortality Rate (%)	11.5	32.5
Shrimp Biomass (kg)	3.542	2.695
Total Feed Used (kg)	3.615	3.623
FCR	1.02	1.34

Fig. 12 below shows the result of standard and experimental feed from the device given to the shrimps every seven days.

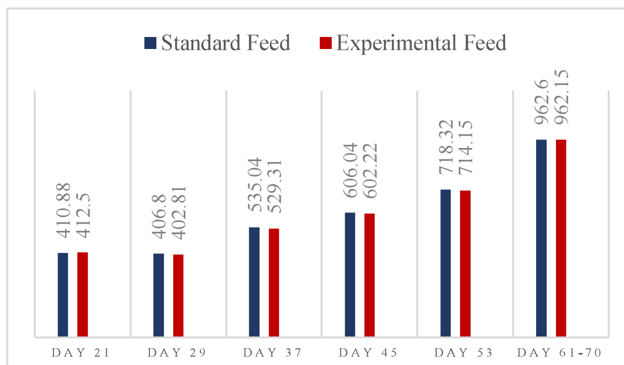

Fig. 12 Graphical Statistical Analysis

The study shall be using the t-test analysis in which the control group will be the standard computed value of the amount of feed. In contrast, the experimental group will be the feed generated by the feeding system produced in this study. The researchers obtained a total accuracy of 96.21% based on the calculation provided by the standard t-test formula. Therefore, the shrimp's weight after 70 days of cultivation using manual feeding and the feeding device are not equal. There is a significant difference between the feed amount generated using manual feeding and the feed amount generated by the feeding system.

III. CONCLUSIONS AND FUTURE WORKS

According to the findings of this study, more efficient feeding management through daily feeding quantity, effective feed distribution, and interval of feeding about the frequency utilizing automatic feeders would promote continuous shrimp development. Feeding management using an automated feeder should provide the lowest FCR to maximize shrimp development and minimize feed waste accumulation at the pond bottom. Increasing feed efficiency through lower FCR is critical for shrimp farmers to reduce costs and maximize profits. The shrimp growth, survival rate (SR), and feeding efficiency were satisfactory during the culture phase. Overall, utilizing an automated feeder provides a healthier shrimp by improving water quality, ensuring continuous feeding, and avoiding overfeeding. Improved water quality, appropriate feeding management, and installing pond monitoring sensors reduce the danger of mortality or disease breakout, resulting in higher profitability and lower labor and production expenses.

For future development, adding specific modules and sensors may enhance or expand the dimension and material of an automated feeder. For pond monitoring, we recommend adding water quality parameters such as dissolved oxygen (DO sensor), water salinity sensor, and alkalinity sensor to maintain the excellent water quality of the pond, which enables shrimps to develop faster. In addition to future automated feeder development for feeding management, we suggest installing a sensor to detect the state of feeds within the container, whether empty or complete, and sending the information via the Global System for Mobile Communications (GSM Module).

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APPENDICES

APPENDIX A

Development and Design of Automated Feeding Device for L. *vannamei* Shrimp Aquaculture

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Abstract—**Shrimp cultivation has become a worthwhile business activity, as it provides food security. The most important aquacultural activity is shrimp farming, where the feeding system and feeder play a major role in the success of aquaculture farms worldwide. In line with this fact, an automated feeding device was designed and developed to feed the shrimp at a predetermined time. It is controlled through a microprocessor to perform the tasks of identifying the total feed weight and disseminating of feed to the pond. The device was utilized various industrial materials and was actualized through fabrication and integration. The dispense and throw of feeds are measured from 0 to the maximum distance of 3 meters. The feeding time is set 3 times a day according to the shrimp's average body weight through sampling. Therefore, the automated feeding device can feed the shrimps at a predetermined time.**

***Index Terms*— automated feeder, shrimp farming, microprocessor**

I. INTRODUCTION

Several automatic shrimp feeders have been developed in the past few years to ease the work requirements in shrimp production by using Arduino Uno in the design of an automatic shrimp feeder system. The device can provide shrimps food at different time intervals. Also, these devices can be programmed to guarantee that the feeding plan is followed accordingly. While these programmable shrimp feeders are easily available for shrimp farmers in developed countries [1]. Automatic feeders are found to be suitable for P. vannamei culture owing to their feeding behavior. At present, 90% of the shrimp farming in the country is contributed by P. vannamei with the maximum allowed stocking density of60 nos. m-² [2].

Shrimp farming is a business that exists in either a marine or freshwater environment, producing shrimp. The automatic feeders are designed to be as bendy as viable so you can use them as stand-alone gadgets or as a part of a totally included packaging machine. Many models are available in Asian countries like Thailand, China, Malaysia, and Vietnam and mixed opinions exist about their application and performance [3]. The predominant task in shrimp farming is to provide feed-in proper amount at the proper time as in line with the requirement. it's miles a truth that the primary running value in aquaculture is the value of feed which might also account for 50% or more. Development of a high-quality feed, as well as the method of feeding, is important since these will affect the overall quantity of feed consumption [4].

Many shrimp farmers report higher shrimp activity after sunset which suggests hence justifying the belief that penaeid shrimp may prefer feeding during nighttime. Yet, feeding through the night can be a challenging practice both logistically and environmentally. General unavailability to work night shifts makes it hard for farms to have enough labor during those hours to assure feeding. Also, and more importantly, most semi-intensive shrimp ponds rely on natural products as the main source of oxygen in the system, hence increasing oxygen consumption because of feeding increases the potential for oxygen depletion. Particularly if the nutrient loading is not spread through multiple meals as well. Nevertheless, identifying potential preferences in the feeding schedule can still be very useful for farms in which oxygen is not a limiting factor, and feeding during that period is logistically possible [5].

Understanding feeding behavior is the basis for any improvement in feed delivery protocols. Shrimp are described as omnivorous benthic animals that favor frequent ingestion of small quantities of food. Multiple authors reported better growth when shrimp were fed multiple feedings during the day. This is most likely due to shorter exposure to water which reduces nutrient leaching, even though shrimp have slower food consumption due to external mastication of most food items [6]. Spreading daily feed inputs through small frequent meals is a preferred practice to mitigate this issue and improve feed delivery efficiency. While many farms still rely on handfeeding 1 to 4 meals a day as a standard feed delivery protocol, the industry is gradually shifting towards more automated feed delivery methods [7]. While timer feeders are a very simple and straightforward tool, substantial effort was put into monitoring shrimp behavior as a tool towards higher efficiency in shrimp production facilities for the past decade [8]. Sound profile in culture ponds was first associated with Penaeus monodon feeding activity (Smith and Tabrett, 2013) and more recently work by Napaumpaipom et al. (2013), Ullman et al. (2019a); Ullman et al. (2019b) and Reis et al.

(2020) using commercially available passive acoustic feeding systems indicated better shrimp growth when compared to less technological solutions such as handfeeding or timer feeders [9].

Although higher technological solutions are available and proven to be very efficient, many producers are not yet ready to invest in the hardware, software, and training that is required. Therefore, it is important to adapt timer feeder protocols to improve growth response [10]. A recent study by Nunes et al. (2019) compared shrimp growth when fed manually and automatically but did not report differences within treatments that fed multiple meals automatically during the day by the opposition with a similar treatment that fed around the clock. [11].

Arduinos are perfect for learning about embedded development, but also for automating regular tasks or even amazing concoctions and contraptions [12]. Servo motors are great devices that can turn to a specified position. Usually, they have a servo arm that can turn 180 degrees. Using the Arduino, we can tell a servo to go to a specified position and it will go there [13]. Load cells are very commonly used for force measurement. Many load cells are flexible load-bearing components or component combinations. The force applied to the elastic element causes it to flex, which converts it into measurable output [14].

II. METHODOLOGY

The contents of this section are the methods and procedures used for the development of the research. In this section, the following are discussed: research design, conceptual framework, and procedures of the design.

For this study, applied research is used as the outline for the whole duration. It aims to come up with a system that will determine the correct amount of shrimp feed to be fed and automation of the feeding process via microcontroller data comparison and manipulation. For the development of the system, knowledge in circuitry, electronics, and microcontroller are involved.

A. Conceptual Framework

Fig. 1 is the conceptual framework of the study. The process, method, and output. The process to be achieved are the feed weighing platform, feed disseminator, and software application. This will be achieved through design, fabrication, and programming. The output is the prototype.

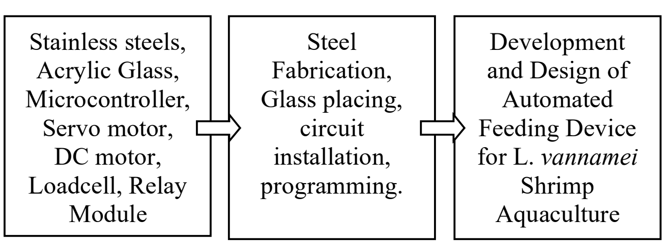

Fig. 1 Conceptual Framework

B. Hardware Development

Below is the design of the Automated Feeding Device.

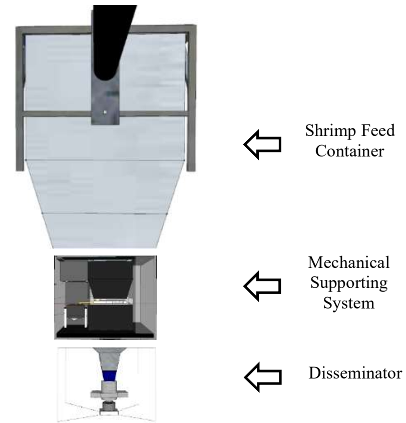

Fig. 2 Design of the Automated Feeding Device

The design involved three parts of the mechanical system which are the shrimp feeds container, mechanical supporting system, and disseminator. The shrimp feed container was designed with two parts. The first part is the container itself which is attached to the second part (mechanical supporting system). The whole system is shown in Fig 3. These include the following:

a) Stainless steel:
A form of chromium-containing steel to ensure the good feed storage of shrimp.
b) Acrylic Glass:
This covers the installation of servo motors and loadcell to hold the feeds before disseminating.
c) Loadcell:
A weight measurement device is necessary to properly weigh the exact amount of feeds to the shrimp.
d) Servo Motors:
A self-contained electrical device, that rotates parts of a machine with high efficiency with great precision. It holds the load cell to control the quantity of feeds before disseminating.
e) Arduino AT-mega:
It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (serial hardware ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset key.
f) DC Motor:
A class of electrical motors that convert direct current electrical energy into mechanical energy. It will help the disseminator to spread out gradually.
g) Disseminator:
it can spread out the total amount of feeds going to the pond.

Below is the design of the automated device supporting system.

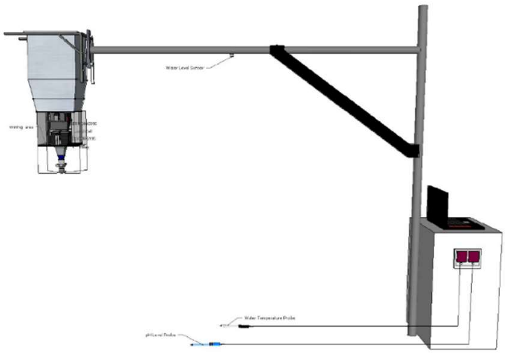

Fig. 3 Design of Automated Device Supporting System

C. Design Procedure

The shrimp feed container is made of a steel plate 0.8 mm thick, 12 x 10 inches in width, and 17 inches in height. This container can be used for 2 kg feeds in it.

The first servo motor that holds the plate to control the feeds goes to the second servo motor with an installed load cell.

The load cell properly weighs the feeds given to the shrimps in time of feeding based on the average body weight of every sampling.

The 5V DC motor is installed to help the disseminator spread the feeds going to the pond.

The relay module is a separate hardware device used for remote device switching. It can automatically stop the DC motor from spinning.

The supporting system has two poles. The first pole is about 19.6 ft (6m) long and is buried about 6 ft (2m) in the ground, while the second pole that holds the feed container is about 6 meters long. It is composed of a twenty-four-inch monitor for the main control of the automated feeding device.

D. Software Features

The servo motors, dc motor, loadcell, disseminator is controlled by relay modules that are connected to the Arduino. C/C++ programming language is utilized.

First, a sample L. *vannamei* shrimp will be weighed. After the weight is determined, the system will cross-reference it with the feeding guide and the cycle schedule of the aquaculture. The flow will result in getting the precise feed amount and schedule. After this, the automatic feeding process will commence by the program using the manipulation of the microcontrollers and relays to control the mechanical part of the system. Then the system will display the current activity status of the feeder. It will also prompt for feed. Stock refill when necessary. Fig. 4 below illustrates the system's flow to accomplish the study's objectives.

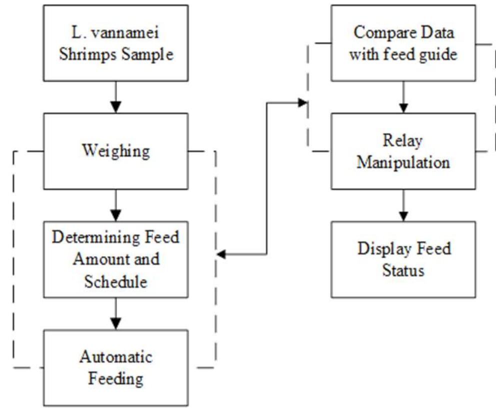

Fig. 4 Device System Flow

E. Sampling & Testing Procedure

The researchers compare shrimp development in culture ponds using an automated feeder and a manual feeding approach to determine the efficiency or effectiveness of the computerized feeder for managing the feeds. The experiment was conducted at Kitagas, Sarangani Province, from May 22, 2021, to July 31, 2021. The growth analysis is divided into two ponds (1 and 2). Pond 1 measures shrimp development using an automated feeder, whereas pond 2 uses manual feeding.

III. RESULTS & DISCUSSION

This chapter presented the results and discussion of the study. It includes the presentation, analysis, and interpretation of data gathered from the testing.

Below is the prototype of the Automated Feeding Device. It is the output of the designed system by the researchers.

Fig. 5 Prototype of Automated Feeding Device

For the development of the device, the researchers were able to develop and actualize the design of the system. Through fabrication and integration of the machine and microprocessors, the system is functional and the data below proves that it is capable of feeding the shrimp automatically.

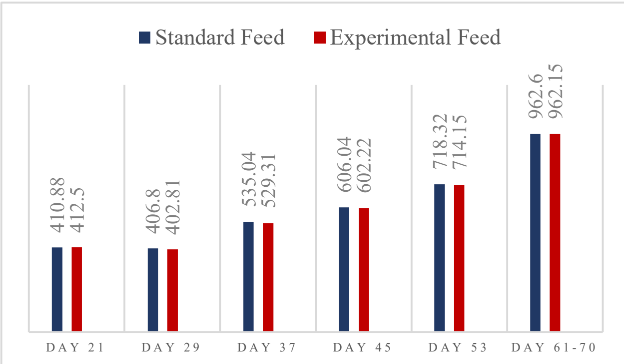

Fig. 6 Graph Statistical Analysis

The study shall be using the t-test analysis in which the control group will be the standard computed value of the amount of feed. In contrast, the experimental group will be the feed generated by the feeding system produced in this study. The researchers obtained a total accuracy of 96.21% based on the calculation provided by the standard t-test formula. Therefore, the shrimp's weight after 70 days of cultivation using manual feeding and the feeding device are not equal. There is a significant difference between the feed amount generated using manual feeding and the feed amount generated by the feeding system.

IV. CONCLUSION & FUTURE WORKS

According to the findings of this study, more efficient feeding management through daily feeding quantity, effective feed distribution, and interval of feeding about the frequency utilizing automatic feeders would promote continuous shrimp development.

Increasing feed efficiency through lower FCR is critical for shrimp farmers to reduce costs and maximize profits. The shrimp growth, survival rate (SR), and feeding efficiency were satisfactory during the culture phase.

For future development, adding specific modules and sensors may enhance or expand the dimension and material of an automated feeder. In addition to future automated feeder development for feeding management, we suggest installing a sensor to detect the state of feeds within the container, whether empty or complete, and sending the information via the Global System for Mobile Communications (GSM Module).

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APPENDIX B

TRADE-OFF ANALYSIS

Design Constraints

This research will consider some constraints to provide order to the beneficiary. The constraints were stated below.

Manufacturability.

Making of the device can be made possible through the existing components and materials in the market.

DESIGN A: (Hanging Automatic Feeder, Arduino Mega and Laptop display)

This design used Arduino Mega, and Laptop. The entire components are provided by the market as it is developmental research. The practical methods from the previous study were enhanced into a new solitary, specifically the previous components and materials.

Correspondingly, other components and materials cannot be found in electronic shops and in shopping centers. In its place, the proponents decided to order in online companies. Since the costs reach the budget of the proponents the entire design can be manufactured. Whether the resources are high or low, the manufacturability is possibly completed. However, the device leads in replacing components because of unattainable duties. Therefore, the manufacturability of this design has more complexity than the second one.

DESIGN B: (Raspberry Pi, Solar powered Floating Automatic Feeder)

The proponent's second design used Raspberry Pi and Solar Powered. The entire components are provided by the market as it is developmental research. The practical methods from the previous study were enhanced into a new solitary, specifically the previous components and materials.

In contrast with the first design, this design saves power consumption since it is supported with a solar panel. Hence, this design has guarantees and is attainable through the given amount of time.

Sustainability.

Maintenance of the components and materials must be done regularly to keep the sustainability. The device will sustain for existences provided that it is used appropriately and controlled with care.

DESIGN A: (Hanging Automatic Feeder, Arduino Mega and Laptop display)

The first entire design provides a long-term device's lifespan since it has durability and performs extensive work time. It is operated through Arduino Mega which reaches minimal command. The design could handle its maximum level of time since it does not limit its power load. Therefore, it completes the work without limitation of power consumption.

DESIGN B: (Raspberry Pi, Solar powered Floating Automatic Feeder)

The second entire device provides a short-term device's lifespan since it limits power consumption. However, it is operated with raspberry pi, where it provides extensive command. Moreover, the device provides sustainability of working lifespan, but it does not apply the sustainability of time – duration because it is only powered by solar type. Hence, this design has less sustainability than the first one.

Environmental.

In the table shown below, the researchers must consider the device's environmental requirements. Both Design A and Design B will consider proper shrimp handling, and there will be no human interaction, as seen in the table. Design B will use solar energy consumption more than Design A.

DESIGN A: (Hanging Automatic Feeder, Arduino Mega and Laptop display)

This design will be considering the efficiency of feeding management to minimize any environmental impacts using automatic feeders.

When it comes to the energy consumption, design A has a better power source to supply the necessary voltage for the entire components. The design could manage its greatest level of time because it does not limit its power load. As a result, it completes the task without limitation of energy consumption.

DESIGN B: (Raspberry Pi, Solar powered Floating Automatic Feeder)

This design will be considering the efficiency of feeding management to minimize any environmental impacts using automatic feeders.

When it comes to the energy consumption, design B can supply a necessary power source to the entire components of the device, but it is limited power load. Therefore, design B could not manage its maximum level of time usage.

Health and Safety.

In the table shown below, the researchers consider the health and safety of the shrimp. Both design A and design B must have no harmful chemicals for humans/animals to be used as well as the consideration of proper arrangement of wires inside the device.

DESIGN A: (Hanging Automatic Feeder, Arduino Mega and Laptop display)

This design will never use harmful chemicals for humans/animals that may result in many diseases. In terms of safety, the user can observe the data by the help of a laptop that has software installed and its result of data will be displayed into the user interface of the system. The user can access conveniently and safely because of the new implementation of the modern development. The user does not necessarily observe manually that can cause destruction from an unusual failing system or disconnection of wires.

DESIGN B: (Raspberry Pi, Solar powered Floating Automatic Feeder)

This design will never use harmful chemicals for humans/animals that may result in many diseases. In terms of safety, the user can observe the data by displaying all the results on the screen provided by the Raspberry Pi. All wires that connect from the feeder to Raspberry Pi are organized inside the system device. Since the device is floating into the pond, the user must necessarily observe the device especially when the weather is not good because there's a possibility that the device will be submerged in water due to heavy rains with strong winds and floods.

Trade-off Analysis.

Since the hardware will be almost the same and the designs will be different in the materials that will be used. Both systems can develop a good Automatic Feeder to manage the shrimp feeds as well as the proper distribution of feeds. The efficiency of the Automatic Feeder for Shrimp using the approach of programming language and materials to be used are being considered to control the feeding per day based on the prescribed feeds per grams of vannamei shrimps.

The researchers will rely on the feeding management for L. vannamei shrimps guide or manual provided by the Charoen Pokphand Foods Philippines Corporation to have a basis for the proper feeding schedules and total feed per day based on the age and average body weight of shrimps. All data must be registered on the system's database. The researchers prefer Design A in terms of manufacturability, sustainability, environmental, and health & safety. By this given constraints, the researchers will choose Design A in terms of accuracy and effectivity.

SELECTION CRITERIA	Constraints Weight (%)	Pugh Concept Selection Matrix	Weight (%)	Design Concepts	
				Design A	Design B
	Manufacturability 24.771%	Can be produced by existing methods	**12.31%**	3	2
		High-quality and low-cost product	**2.44%**	1	2
		Installment of sensors and other component is easier	**1.65%**	2	2
		Materials are readily available	**6.42%**	3	2
	Sustainability 25.512%	Durability	**11.13%**	3	2
		Performance under heavy usage	**5.65%**	2	1
		Life Expectancy	**1.57%**	3	2
		Maintenance	**3.08%**	3	2
	Environmental 18.987%	Environmental Impact	**0.999%**	2	1
		Energy consumption	**3.999%**	3	2
	Health and Safety 30.727%	No harmful chemicals for humans/animals are used	**1.41%**	1	1
		Properly arranged wires	**1.08%**	5	1
		Total Score		**31**	**20**
		Weight Score		**1.403**	**0.93**

Pugh Selection Matrix

Trade-off Analysis Calculations

The comparison between the two designs is shown in the table above, which supports the researchers' decision-making. The table composed of four constraints: the manufacturability, sustainability, environmental and health & safety. These constraints help to determine the preferable design between the two. The table's results that obtain above were gathered through the individual rating of the constraints. However, the constraint has its own basis which provides an overall rating. With the use of matrix formula, solving of individual rates takes place. Furthermore, in comparing the two designs the highest rating is the design A having a total score of 31 points whereas the design B has 20 points. While in weighted score, still the design A has the highest score having 1.403 points and the design B has 0.93 point. Therefore, the researchers choose design A for the study.

The table presented above provides concrete results for choosing the design. Hence, the Trade Off Analysis helps the researchers in a useful manner specifically to the researchers' design.

Pugh Matrix and Computation

COMPARISON OF ALTERNATIVES: WEIGHT OF CRITERIA

Use the following concept Selection:

1. Equal 2. Moderate 3. Strong 4. Very Strong 5. Extreme

Use the following for Concept Scoring:

Value	Interpretation
1	i and j are equally important
2	i is slightly more important than j
3	i is more important than j
4	i is strongly more important than j

5	i is absolutely more important than j

Constraints

A	Manufacturability
B	Sustainability
C	Environmental
D	Health and Safety

$$
\begin{array}{c|cccccccc|}
 & A & & B & & C & & D & \\
A & 1 & 1 & 3 & 5 & 2 & 4 & 3 & 2 \\
B & 5 & 4 & 1 & 1 & 3 & 2 & 2 & 1 \\
C & 3 & 2 & 1 & 3 & 1 & 1 & 2 & 1 \\
D & 2 & 1 & 3 & 5 & 3 & 2 & 1 & 1
\end{array}
$$

Squaring the Matrix:

$$
\begin{array}{|cccc|ccc}
 & & & & & \text{Sum} & \text{Weight (\%)} \\
5.5 & 2.264 & 4.15 & 5.2 & & \mathbf{17.114} & \mathbf{18.987\%} \\
8.75 & 3.445 & 6.625 & 8.875 & = & \mathbf{27.695} & \mathbf{30.727\%} \\
7.412 & 2.76 & 5.245 & 6.91 & & \mathbf{22.327} & \mathbf{24.771\%} \\
7 & 2.895 & 4.9 & 8.2 & & \mathbf{22.995} & \mathbf{25.512\%} \\
\hline
 & & & & & \mathbf{90.131} & \mathbf{100\%}
\end{array}
$$

Manufacturability (22.82%)

A Materials are readily available

B Can be produced by existing methods

C High-quality and low-cost products

D Installment of sensors and other equipment is easier

	A		B		C		D	
A	1	1	1	2	3	2	3	1
B	2	1	1	1	2	1	2	1
C	1	2	1	2	1	1	3	2
D	2	3	1	2	1	2	1	1

Squaring the Matrix:

					Sum	Weight (%)	Actual weight (%)
4.55	3.25	5.5	9.25		22.55	28.508%	**6.42%**
6.2	4	8	13	=	31.2	39.443%	**12.31%**
2.9	2	3.5	5.5		13.9	17.572%	**2.44%**
2.45	1.55	2.9	4.55		11.45	14.475%	**1.65%**
					79.1	100%	**22.82%**

Sustainability (21.43%)

A Durability

B Performance under heavy usage

C Maintenance

D Life Expectancy

	A		B		C		D	
A	1	1	2	1	2	1	3	2
B	1	3	1	1	2	1	2	1
C	2	3	1	3	1	1	2	1
D	1	3	2	3	2	3	1	1

Squaring the Matrix:

					Sum	Weight (%)	Actual weight (%)
3.475	5.65	8.99	11		29.115	38.23%	**11.13%**
2.64	3.64	5.98	8.495	=	20.755	27.25%	**5.65%**
2.088	3.3	4.3	5.65		15.338	20.14%	**3.08%**
1.313	2.197	3.3	4.135		10.945	14.37%	**1.57%**
					76.153	100%	**21.43%**

Environmental (4.998%)

A Environmental Impact

B Energy consumption

	A		B	
A	1	1	1	2
B	2	1	1	1

Squaring the Matrix:

			Sum	Weight (%)	Actual Weight (%)
2	1		3	33.33%	**0.999%**
4	2	=	6	66.66%	**3.999%**
					4.998%
			9	100%	

Health and Safety (2.49%)

A No harmful chemicals for humans/animals are used

B Properly arranged wires

A	B

$$
\begin{array}{c} A \\ \\ B \\ \\ \end{array}
\begin{vmatrix} 1 & 1 & 2 & 3 \\ & & & \\ 3 & 2 & 1 & 1 \\ & & & \end{vmatrix}
$$

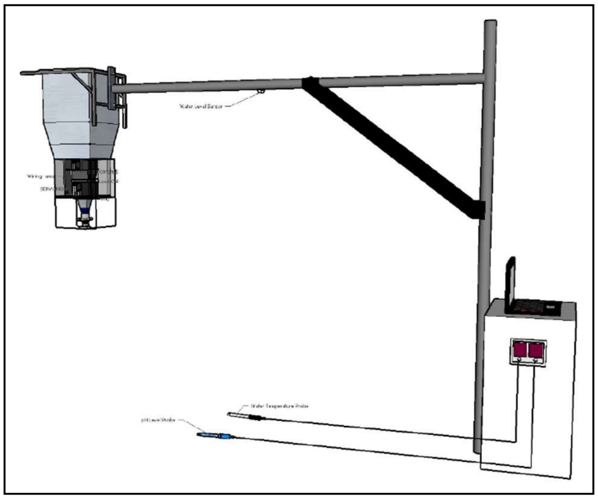
Squaring the Matrix:

$$
\begin{vmatrix} 1.33 & 1.32 \\ & \\ 1 & 1.33 \\ & \end{vmatrix} =
$$

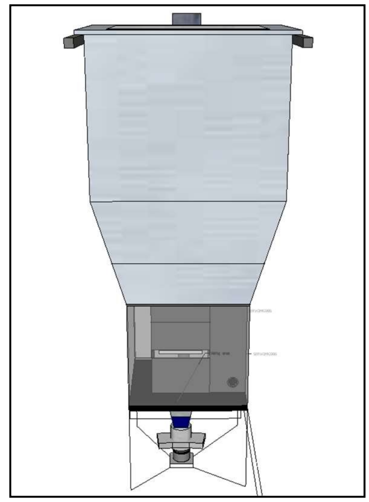
Sum	Weight (%)	Actual weight (%)
2.65	53.21%	**1.41%**
2.33	46.78%	**1.08%**
4.98	100%	**2.49%**

APPENDIX C

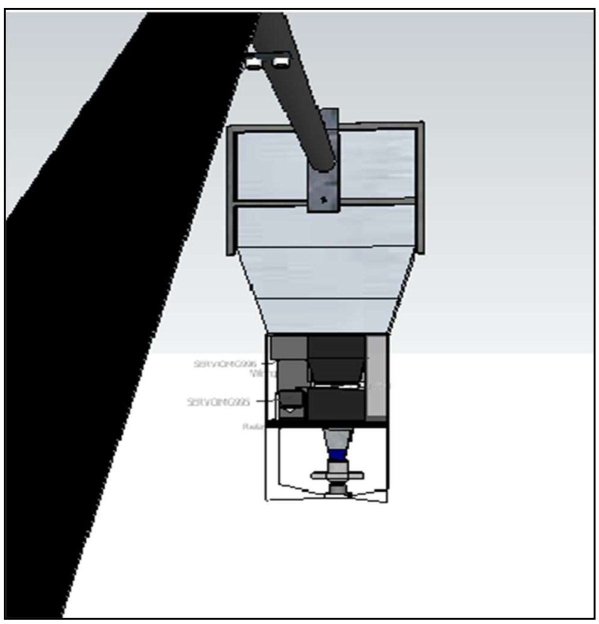
DESIGN, DIAGRAM, AND GRAPHICAL USER INTERFACE



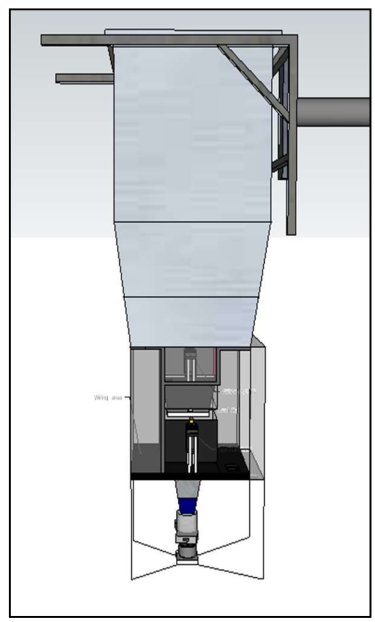
3D VIEW



BACK VIEW



FRONT VIEW



SIDE VIEW

Fig. 1 Physical Design of Prototype Automated Feeder Device

Fig. 1 depicts the final design of the Automated Feeder Device, including 3D, back, front, and side perspectives. The circuits were installed near the motor 3 that is responsible for holding the acrylic glass sheet on which the load cell is located. The device was constructed, and it is made of steel for the feed container and acrylic glass for the installation of all the components.

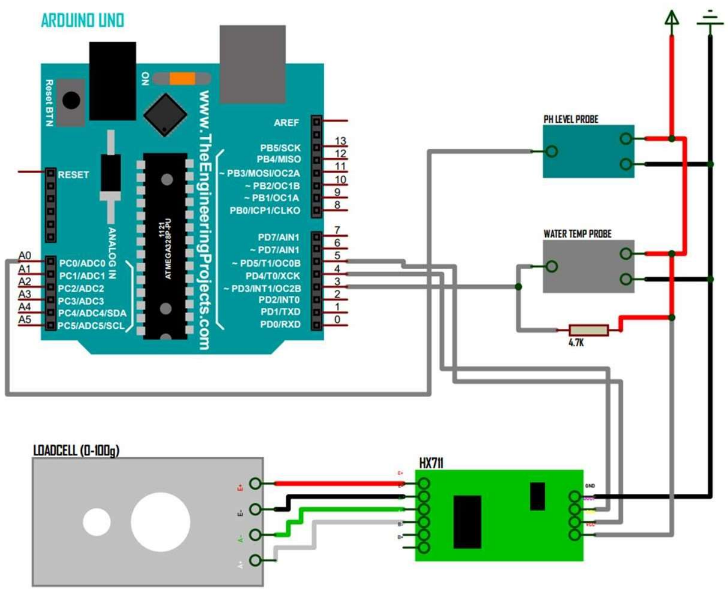


Fig. 2 Schematic Diagram of Pond Monitoring System

The schematic diagram for the Pond Monitoring System is shown in Figure 2. The load cell, water temperature sensor, and pH level sensor were all controlled by the Arduino Uno R3. The researchers used a DS18B20 to measure the pond's water temperature, an Arduino pH meter kit to measure the acidity of the water, and a load cell (0-100 g capacity) with a HX711 module to weigh the shrimp at each sampling. All data generated by the sensors and the load cell will be shown in the research's user interface.

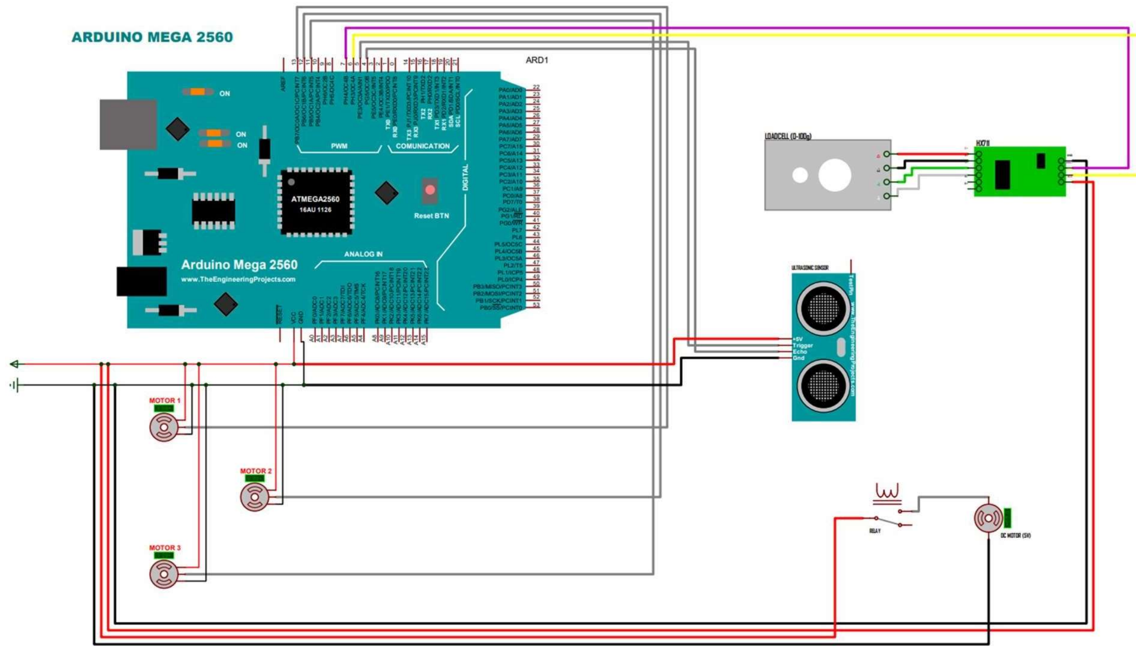


Fig. 3 Schematic Diagram of Automated Feeder Device

Fig. 3 depicts the Automated Feeder Device schematic design. The three servomotors, load cell with HX711, water level sensor, relay module, and 5 volts DC motor were all controlled by the Arduino Mega 2560. The researchers used MG995 servomotors for high-speed rotation for rapid reaction, an ultrasonic sensor to measure the water level, a load cell (0-100g capacity) to measure the feeding, and a relay module to regulate the current flow flowing to the dc motor based on the condition executed in the program.

Fig. 4 Graphical User Interface

Fig. 4 depicts the user interface of the study. It has a display that shows the readings from the pond's water temperature, pH level, and water level. It also shows the feeding status while the prototype automated feeder is in use, including total feed per day, feed distribution, feeding frequency, and the date of time.

APPENDIX D

SOFTWARE SOURCE CODE

Visual Basic Code

```
Imports MySql
Imports MySql.Data.MySqlClient
Imports System.Data
Imports System.IO
Imports System.IO.Ports

Public Class Form1
    'Dim table As New DataTable("Table")
    Dim conn As MySqlConnection
    Dim myCommand As New MySqlCommand
    Dim myAdapter As New MySqlDataAdapter
    Dim myData As New DataTable
    Dim dr As MySqlDataReader
    Dim ds, dsl As New DataSet
    Dim SQL As String
    Public Shared Day_Num As Integer
    Dim value1 As Decimal
    Dim value2 As Decimal
    Dim value3 As Decimal
    Dim time_loop As Integer = 1
    Dim Day As Integer
    Dim Month As Integer
    Dim Year As Integer
    Dim value4 As Decimal = 0
    Dim var As Integer = 0
    Dim motor As Integer = 1
    Dim looper As Integer = 0
    Dim motor2 As Integer = 0
    Dim dis As Integer
    Dim dis2 As Decimal = 0.00
    Public Port_Num As String
    Public Time As String
    Public Date_Now As String
    Dim Population As Integer
    Dim ABW As Decimal
    Dim Feed_Rate As Decimal
    Dim Total_Feed_Day As Decimal
    Dim Feed_Dist As Decimal
    Dim Biomass As Decimal
    Dim Per As Decimal
    Dim dis3 As Integer = 0
    Dim feed1 As Decimal = 0
    Dim feed2 As Decimal = 0
    Dim feed3 As Decimal = 0
    Dim total As Decimal = 0
```

```
Dim con As Integer = 0

Private Sub Timer1_Tick(sender As Object, e As EventArgs) Handles Timer1.Tick

    ABW = Convert.ToDecimal(Label29.Text)
    Population  =  Convert.ToDecimal(Label30.Text)

    If ABW >= 3 And ABW <= 3.74 Then
        Feed_Rate = 0.08
        FeedRate.Text = "8.00"

    ElseIf ABW >= 3.75 And ABW <= 5.24 Then
        Feed_Rate = 0.06
        FeedRate.Text = "6.00"

    ElseIf ABW >= 5.25 And ABW <= 6.9 Then
        Feed_Rate = 0.045
        FeedRate.Text = "4.50"

    ElseIf ABW >= 7 And ABW <= 8.9 Then
        Feed_Rate = 0.04
        FeedRate.Text = "4.00"

    ElseIf ABW >= 9 And ABW <= 11.4 Then
        Feed_Rate = 0.035
        FeedRate.Text = "3.50"

    ElseIf ABW >= 11.5 And ABW <= 14.4 Then
        Feed_Rate = 0.032
        FeedRate.Text = "3.20"

    ElseIf ABW >= 14.5 And ABW <= 17.4 Then
        Feed_Rate = 0.028
        FeedRate.Text = "2.80"

    ElseIf ABW >= 17.5 And ABW <= 19.9 Then
        Feed_Rate = 0.025
        FeedRate.Text = "2.50"

    ElseIf ABW >= 20 And ABW <= 21.9 Then
        Feed_Rate = 0.023
        FeedRate.Text = "2.30"

    ElseIf ABW >= 22 And ABW <= 23.9 Then
        Feed_Rate = 0.021
        FeedRate.Text = "2.10"

    ElseIf ABW >= 24 And ABW <= 25 Then
        Feed_Rate = 0.02
        FeedRate.Text  =  "2.00"
    End If

    Total_Feed_Day = Population * ABW * Feed_Rate
    Total_Feed.Text  =  Format$(Total_Feed_Day,  "Fixed")
```

```
        Biomass = (Population * ABW) / 1000
        Label39.Text =  Format$(Biomass,  "Fixed")

        Feed_Dist = Total_Feed_Day / 3
        D_1.Text = Format$(Feed_Dist, "Fixed")
        D_2.Text = Format$(Feed_Dist, "Fixed")
        D_3.Text = Format$(Feed_Dist, "Fixed")

        If Population = 0 Then
            Population = 1
        End If
        Per = Total_Feed_Day / Population
        Label31.Text =  Format$(Per,  "Fixed")

dis = Feed_Dist

        dis2 = dis + 0.1

Dim s As String

        s = TextBox1.Text + "," + ""

        Dim somestring() As String
        somestring = s.Split(New Char() {","c})

        Water_Level.Text = somestring(0)
        If Water_Level.Text = "" Then
            Water_Level.Text = value1
        Else
            Try
                value1 = Convert.ToDecimal(Water_Level.Text)
            Catch ex As Exception
                value1 = value1
            End Try
        End If

        If value1 > 1 Then
            Label46.Text = "below normal"

        ElseIf value1 < 3 Then
            Label46.Text = "above normal"

        Else
            Label46.Text = "average"

        End If

Label15.Text = somestring(1)
        If Label15.Text = "" Then
            Label15.Text = value4
            If Label15.Text < 0 Then
                Label15.Text = "0"
            End If
        Else
            Try
```

```
            value4 = Convert.ToDecimal(Label15.Text)
            Label48.Text = value4
        Catch ex As Exception
            value4 = value4
        End Try

End If
        TextBox1.Text = ""

  If Time_Hours.Text = Time_1.Text Or Time_Hours.Text = Time_2.Text Or Time_Hours.Text =
Time_3.Text Then

        If time_loop = 1 And looper = 0 Then

    'Motor 1 Open here

            SerialPort1.Write("1")
            Label47.Text = "1"

SerialPort1.Write("0")

looper = 1

  End If

        If value4 >= dis And value4 <= dis2 Then

            If Label57.Text = "00.00" Then

                Label57.Text = value4

                feed1 = value4

                con = 1

            ElseIf Label60.Text = "00.00" And con = 0 Then

                Label60.Text = value4

                feed2 = value4

                con = 1

            ElseIf Label63.Text = "00.00" And con = 0 Then

                Label63.Text = value4

                feed3 = value4

                total = feed1 + feed2 + feed3

            End If

            total = feed1 + feed2 + feed3

            'Motor 1 close

            SerialPort1.Write("0")

            SerialPort1.Write("2")
```

```
            Label47.Text = "2"
SerialPort1.Write("0")
'Motor 2 Open
            SerialPort1.Write("3")
motor = 0
End If
         If Label15.Text >= 0 And Label15.Text < 1 And motor = 0 Then
            'Motor 2 Close
            motor2 = 0
            SerialPort1.Write("0")
            SerialPort1.Write("4")
time_loop = 0
            motor = 1
End If
      Else
         time_loop = 1
         looper = 0
         con = 0
      End If
If Label57.Text IsNot "00.00" Then
         feed1 = Convert.ToDecimal(Label57.Text)
      End If
      If Label60.Text IsNot "00.00" Then
         feed2 = Convert.ToDecimal(Label60.Text)
      End If
      If Label63.Text IsNot "00.00" Then
         feed3 = Convert.ToDecimal(Label63.Text)
      End If
      total = feed1 + feed2 + feed3
      Label65.Text =  Convert.ToString(total)
End Sub
Private Sub btnControl_Click(sender As Object, e As EventArgs) Handles btnControl.Click
```

```
        Control.Show()
    End Sub
Private Sub Form1_Load(sender As Object, e As EventArgs) Handles MyBase.Load
Loading.Show()
End Sub
Private Sub btnWeight_Click(sender As Object, e As EventArgs) Handles btnWeight.Click
        Weight.Show()
        Weight.Timer1.Enabled = True
    End Sub
Private Sub motor_button_Click(sender As Object, e As EventArgs) Handles motor_button.Click
   SerialPort1.Write("1")
If value4 >= 10.0 And value4 <= 12.0 Then  '(Note: pag wala pa na meet ang required na weight, di
mag close ang 1st motor)
            var = 1
            'Motor 1 close
            SerialPort1.Write("0")
            SerialPort1.Write("2")
            System.Threading.Thread.Sleep(1000) 'Note: to give time pra sa arduino na maka catch up if
naay data traffic
            SerialPort1.Write("0")
            'delay of 5 seconds before opening of 2nd motor
            System.Threading.Thread.Sleep(6000)
            'Motor 2 Open
            SerialPort1.Write("3")
            System.Threading.Thread.Sleep(2000)
            'SerialPort1.Write("0")
        End If
        If Label15.Text >= 0 And Label15.Text <= 1 Then  'Note: mag close amg motor 2 if wala nay
weight sa loadcell
                'Motor 2 Close
                SerialPort1.Write("0")
                SerialPort1.Write("4")
                System.Threading.Thread.Sleep(2000)
```

```
            SerialPort1.Write("0")
          var = 0
        End If
    End Sub
    Private Sub Button1_Click(sender As Object, e As EventArgs) Handles Button1.Click
        Alert.Show()
    End Sub
Private Sub btnData_Click(sender As Object, e As EventArgs) Handles btnData.Click
        Data.Show()
    End Sub
Private Sub Timer2_Tick_2(sender As Object, e As EventArgs) Handles Timer2.Tick
        Date_Day.Text = Format(Now, "dd")
        Date_Month.Text = Format(Now, "MM")
        Date_Year.Text = Format(Now, "yyyy")
        Time_Hours.Text = Format(Now, "HH")
        Time_Minutes.Text = Format(Now, "mm")
        Time_Seconds.Text = Format(Now, "ss")
        'Day_Number.Text = Date_Day.Text 'to be changed
        Day_Num = Day_Number.Text 'to be changed
        Time = Time_Hours.Text + ":" + Time_Minutes.Text + ":" + Time_Seconds.Text
        Date_Now = Date_Month.Text + " " + Date_Day.Text + " " + Date_Year.Text
    End Sub
Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
        If feed1 > 0 And feed2 > 0 And feed3 > 0 Then
          Dim conn As New MySqlConnection
          Dim cmd As New MySqlCommand
          Try
            conn.ConnectionString = "server=localhost;user id=root;" &
"password=;database=dbshrimp_data"
            conn.Open()
            cmd.Connection = conn
```

```
            cmd = New MySqlCommand("INSERT INTO `feed`(`Day`, `1st Distribution`, `2nd Distribution`, `3rd Distribution`, `Total Feed of Day`) VALUES('" & Day_Number.Text & "','" & feed1 & "','" & feed2 & "','" & feed3 & "','" & total & "')", conn)

            cmd.ExecuteNonQuery()

            'MessageBox.Show("Data  Saved")

            'Me.Close()

        Catch ex As Exception

            MessageBox.Show("Invalid"  & ex.Message)

        Finally

            conn.Close()

        End Try

    End If

    MessageBox.Show("Values stored are only those that have complete a cycle (fed 3 times on the current day) ")

    Feed_Chart.Show()

  End Sub

Private Sub DataReceived(ByVal sender As Object, ByVal e As SerialDataReceivedEventArgs) Handles SerialPort1.DataReceived

    Try

        Dim mydata As String = ""

        mydata = Me.SerialPort1.ReadExisting()

        If TextBox1.InvokeRequired Then

            TextBox1.Invoke(DirectCast(Sub() TextBox1.Text &= mydata, MethodInvoker))

        Else

            TextBox1.Text &= mydata

        End If

    Catch ex As Exception

        MessageBox.Show(ex.Message)

    End Try

  End Sub

End Class


Public Class Control
```

```
Private Sub Button4_Click(sender As Object, e As EventArgs) Handles Back.Click
    Me.Close()
End Sub

Private Sub Start_Click(sender As Object, e As EventArgs) Handles Start.Click
    Start.Enabled = False
    Reset.Enabled = True
    Stoop.Enabled = True
    'Form1.Day_Number.Text = 20
    Information.Show()
End Sub
Private Sub Reset_Click(sender As Object, e As EventArgs) Handles Reset.Click
    Start.Enabled = True
    Reset.Enabled = False
    Stoop.Enabled = False

    Form1.Timer1.Enabled = False
    Weight.Timer1.Enabled =  False

    Form1.D_1.Text = "00.00"
    Form1.D_2.Text = "00.00"
    Form1.D_3.Text = "00.00"

    Form1.Day_Number.Text = "00"
    Form1.Label29.Text = "00.00"
    Form1.Label31.Text = "00.00"
    Form1.FeedRate.Text = "00.00"
    Form1.Label30.Text = "00"
    Form1.Label39.Text = "00.00"
    Form1.Total_Feed.Text = "00.00"
    Form1.Ph_Level.Text  =  "0.00"
    Form1.Water_Level.Text  =  "0"
```

```
        Form1.Water_Temp.Text = "00.00"
        Form1.Label57.Text = "00.00"
        Form1.Label60.Text = "00.00"
        Form1.Label63.Text = "00.00"
        Form1.Label65.Text = "00.00"
    End Sub
    Private Sub Stoop_Click(sender As Object, e As EventArgs) Handles Stoop.Click
        Start.Enabled = True
        Reset.Enabled = True
        Stoop.Enabled = False

        Form1.Timer1.Enabled = False
        Weight.Timer1.Enabled = False
    End Sub
    Private Sub PictureBox1_Click(sender As Object, e As EventArgs) Handles PictureBox1.Click
    End Sub
End Class

Public Class Data
    Dim conn As MySqlConnection
    Dim myCommand As New MySqlCommand
    Dim myAdapter As New MySqlDataAdapter
    Dim myData As New DataTable
    Dim dr As MySqlDataReader
    Dim ds, dsl As New DataSet
    Dim SQL As String
    Private Sub btn_Save_Click(sender As Object, e As EventArgs) Handles btn_Save.Click

    End Sub
    Private Sub Data_Load(sender As Object, e As EventArgs) Handles MyBase.Load
        conn = New MySqlConnection()
```

```
        conn.ConnectionString = "server=localhost;user id=root;" &
"password=;database=dbshrimp_data"
        Try
            conn.Open()
            SQL = "Select * From data"
            myCommand.Connection = conn
            myCommand.CommandText = SQL
            myAdapter.SelectCommand = myCommand
            myAdapter.Fill(myData)
            DataGridView1.DataSource = myData
            conn.Close()
        Catch myerror As MySqlException
            MessageBox.Show("Error: " & myerror.Message)
        Finally
            conn.Dispose()
        End Try
        Day_Num.Text = Form1.Day_Number.Text
        Water_Temp.Text  = Form1.Water_Temp.Text
        Water_Level.Text = Form1.Water_Level.Text
        PH_Level.Text = Form1.Ph_Level.Text
        ABW.Text = Form1.Label29.Text
        Feed_Type.Text = Form1.Label8.Text
        Frequency.Text = Form1.Label50.Text
        Feed_per_dis.Text = Form1.D_1.Text
        Per_Day.Text = Form1.Total_Feed.Text
        lblDate.Text = Form1.Date_Now
        lblTime.Text = Form1.Time
        Feed_Shrimp.Text = Form1.Label31.Text
        Feed_Rate.Text = Form1.FeedRate.Text
        Pop.Text = Form1.Label30.Text
        Biomass.Text = Form1.Label39.Text
        Time_feed1.Text = Form1.Time_1.Text
```

```
        Time_feed2.Text = Form1.Time_2.Text

        Time_feed3.Text  =  Form1.Time_3.Text

    End Sub


    Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click

        Dim conn As New MySqlConnection

        Dim cmd As New MySqlCommand

        Try

            conn.ConnectionString = "server=localhost;user id=root;" &
"password=;database=dbshrimp_data"

            conn.Open()

            cmd.Connection = conn

            cmd = New MySqlCommand("INSERT INTO `data`(`Day`, `Date_Rec`, `Time_Rec`,
`Population_Rec`, `Time_1`, `Time_2`, `Time_3`, `Average Body Weight g`, `Feed_Type`, `Total
Feed per Day g`, `Total Feed per Distribution g`, `Total Feed per Shrimp g`, `Frequency`, `Feed Rate
%`, `Biomass kg`, `Water Level m`, `Water temp C`, `Ph Level`) VALUES('" & Day_Num.Text &
"','" & lblDate.Text & "','" & lblTime.Text & "','" & Pop.Text & "','" & Time_feed1.Text & "','" &
Time_feed2.Text & "','" & Time_feed3.Text & "','" & ABW.Text & "','" & Feed_Type.Text & "','" &
Per_Day.Text & "','" & Feed_per_dis.Text & "','" & Feed_Shrimp.Text & "','" & Frequency.Text &
"','" & Feed_Rate.Text & "','" & Biomass.Text & "','" & Water_Level.Text & "','" &
Water_Temp.Text & "','" & PH_Level.Text & "')", conn)

            cmd.ExecuteNonQuery()

            Day_Num.Text = ""

            Water_Temp.Text = ""

            Water_Level.Text = ""

            PH_Level.Text = ""

            ABW.Text = ""

            Feed_Type.Text = ""

            Frequency.Text = ""

            Feed_per_dis.Text = ""

            Per_Day.Text = ""

            lblDate.Text = ""

            lblTime.Text = ""

            Feed_Shrimp.Text = ""

            Feed_Rate.Text = ""
```

```
            Pop.Text = ""
            Biomass.Text = ""
            Time_feed1.Text = ""
            Time_feed2.Text = ""
            Time_feed3.Text = ""
            MessageBox.Show("Data Saved")
            Me.Close()
        Catch ex As Exception
            MessageBox.Show("Invalid"  &  ex.Message)
        Finally
            conn.Close()
        End Try



    End Sub
    Private Sub btn_Refresh_Click(sender As Object, e As EventArgs) Handles btn_Refresh.Click
        DataGridView1.DataSource = Nothing
        'DataGridView1.Refresh()
        conn = New MySqlConnection()
        conn.ConnectionString = "server=localhost;user id=root;" &
"password=;database=dbshrimp_data"
        Try
            conn.Open()
            SQL = "Select * From data"
            myCommand.Connection = conn
            myCommand.CommandText = SQL
            myAdapter.SelectCommand = myCommand
            myAdapter.Fill(myData)
            DataGridView1.DataSource = myData
            conn.Close()
        Catch myerror As MySqlException
            MessageBox.Show("Error: " & myerror.Message)
```

```
        Finally
            conn.Dispose()
        End Try
    End Sub
    Private Sub Button1_Click(sender As Object, e As EventArgs) Handles Button1.Click
        Me.Close()
    End Sub
End Class

Public Class Feed_Chart
    Dim conn As MySqlConnection
    Dim myCommand As New MySqlCommand
    Dim myAdapter As New MySqlDataAdapter
    Dim myData As New DataTable
    Dim dr As MySqlDataReader
    Dim ds, dsl As New DataSet
    Dim SQL As String
    Private Sub DataGridView1_CellContentClick(sender As Object, e As
DataGridViewCellEventArgs) Handles DataGridView1.CellContentClick
    End Sub
    Private Sub btnData_Click(sender As Object, e As EventArgs) Handles btnData.Click
        Me.Close()
    End Sub
    Private Sub Feed_Chart_Load(sender As Object, e As EventArgs) Handles MyBase.Load
        conn = New MySqlConnection()
        conn.ConnectionString = "server=localhost;user id=root;" &
"password=;database=dbshrimp_data"
        Try
            conn.Open()
            SQL = "Select * From feed"
            myCommand.Connection = conn
            myCommand.CommandText = SQL
```

```
            myAdapter.SelectCommand = myCommand
            myAdapter.Fill(myData)
            DataGridView1.DataSource = myData
            conn.Close()
        Catch myerror As MySqlException
            MessageBox.Show("Error: " & myerror.Message)
        Finally
            conn.Dispose()
        End Try
    End Sub
End Class
Public Class Information
    Dim feed1 As Decimal = 0
    Dim feed2 As Decimal = 0
    Dim feed3 As Decimal = 0
    Dim total As Decimal = 0
    Private Sub Button1_Click(sender As Object, e As EventArgs) Handles Button1.Click
        Form1.Day_Number.Text = Day_Num.Text
        Form1.Label29.Text = Format$(ABW_Reading.Text, "Fixed")
        Form1.Label30.Text = Population.Text
        Form1.Timer1.Enabled = True
        Weight.Timer1.Enabled = True
        Form1.btnWeight.Enabled = True
        'Form1.btnGuide_Chart.Enabled = True
        Form1.btnData.Enabled = True
        If CheckBox5.Checked = True Then
            If CheckBox1.Checked = True Then
                Form1.Label57.Text =  TextBox1.Text
                feed1 = Convert.ToDecimal(TextBox1.Text)
            End If
            If CheckBox2.Checked = True Then
                Form1.Label60.Text = TextBox2.Text
```

```
            feed2 = Convert.ToDecimal(TextBox2.Text)
        End If
        If CheckBox3.Checked = True Then
            Form1.Label63.Text =  TextBox3.Text
            feed3 = Convert.ToDecimal(TextBox3.Text)
        End If
        If CheckBox4.Checked = True Then
            Form1.Label65.Text = TextBox4.Text
            total = TextBox4.Text
        Else
            total = feed1 + feed2 = feed3
            Form1.Label65.Text =  Convert.ToString(total)
        End If
    End If


    Me.Close()
    Control.Hide()
End Sub
Private Sub ABW_Reading_TextChanged(sender As Object, e As EventArgs) Handles
ABW_Reading.TextChanged
End Sub
Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
    Me.Close()
End Sub
Private Sub RadioButton1_CheckedChanged(sender As Object, e As EventArgs)
End Sub
Private Sub CheckBox1_CheckedChanged(sender As Object, e As EventArgs) Handles
CheckBox1.CheckedChanged
    If CheckBox1.Checked = True Then
        TextBox1.Visible = True
        Label4.Visible = True
    End If
```

```
    End Sub

    Private Sub CheckBox2_CheckedChanged(sender As Object, e As EventArgs) Handles
CheckBox2.CheckedChanged

        If CheckBox1.Checked = True Then

            TextBox2.Visible = True

            Label5.Visible = True

        End If

    End Sub

    Private Sub TextBox3_TextChanged(sender As Object, e As EventArgs) Handles
TextBox3.TextChanged

    End Sub

    Private Sub CheckBox3_CheckedChanged(sender As Object, e As EventArgs) Handles
CheckBox3.CheckedChanged

        If CheckBox1.Checked = True Then

            TextBox3.Visible = True

            Label6.Visible = True

        End If

    End Sub

    Private Sub Information_Load(sender As Object, e As EventArgs) Handles MyBase.Load

    End Sub

    Private Sub CheckBox5_CheckedChanged(sender As Object, e As EventArgs) Handles
CheckBox5.CheckedChanged

        If CheckBox5.Checked = True Then

            GroupBox1.Visible = True

        Else

            GroupBox1.Visible = False

        End If

    End Sub

    Private Sub CheckBox4_CheckedChanged(sender As Object, e As EventArgs) Handles
CheckBox4.CheckedChanged

        If CheckBox4.Checked = True Then

            TextBox4.Visible = True

            Label7.Visible = True
```

```
        End If
    End Sub
    Private Sub GroupBox1_Enter(sender As Object, e As EventArgs) Handles GroupBox1.Enter
    End Sub
End Class

Public Class Loading
    Dim Increment As Integer = 0
    Public button As Integer = 0
    Private Sub ProgressBar1_Click(sender As Object, e As EventArgs) Handles ProgressBar1.Click
    End Sub
    Private Sub Loading_Load(sender As Object, e As EventArgs) Handles MyBase.Load
        ' Chart.Show()
        'Chart.Opacity = 0.0
        Me.BringToFront()
        Me.CenterToScreen()
        Form1.Hide()
        'System.Threading.Thread.Sleep(5000)
        Port_Number.Show()
        Port_Number.BringToFront()
    End Sub
    Private Sub Timer1_Tick(sender As Object, e As EventArgs) Handles Timer1.Tick
        'If Timer1.Interval > Increment Then
        Port_Number.BringToFront()
        'Chart.Show()
        'Chart.Opacity = 0.0
        'Else
        '
        'End If
        If button = 1 Then
            ProgressBar1.Value += 1
            label9.Text = ProgressBar1.Value & "%"
```

```
        If ProgressBar1.Value = ProgressBar1.Maximum Then
            'Timer1.Enabled = False
            'Chart.Hide()
            'Chart.Opacity = 100
            Me.Close()
            Form1.Show()
            'Form1.Timer1.Enabled = True
            Form1.Timer2.Enabled = True
            'Weight.Timer1.Enabled = True
        End If
    End If
End Sub
```

```
Public Class Port_Number
    Dim sp As String
    Private Sub ComboBox1_SelectedIndexChanged(sender As Object, e As EventArgs) Handles
ComboBox1.SelectedIndexChanged
        For Each sp In My.Computer.Ports.SerialPortNames
            ComboBox2.Items.Add(sp)
        Next
        ComboBox2.Items.RemoveAt(ComboBox1.SelectedIndex)
        If ComboBox2.Items.Count > 0 Then
            ComboBox2.SelectedIndex = 0    ' The first item has index 0 '
        End If
    End Sub
    Private Sub Port_Number_Load(sender As Object, e As EventArgs) Handles MyBase.Load
        ' Show all available COM ports.
        For Each sp In My.Computer.Ports.SerialPortNames
            ComboBox1.Items.Add(sp)
            'ComboBox2.Items.Add(sp)
        Next
        'If ComboBox1.Items.Count > 0 Then
```

```
    '    ComboBox1.SelectedIndex = 0    ' The first item has index 0 '
    'End If
End Sub
Private Sub Button1_Click(sender As Object, e As EventArgs) Handles Button1.Click
    Try
        Form1.Port_Num = ComboBox1.Text
        Form1.SerialPort1.Close()
        Form1.SerialPort1.PortName = ComboBox1.Text 'com port sa arduino
        Form1.SerialPort1.BaudRate = "57600"
        Form1.SerialPort1.DataBits = 8
        Form1.SerialPort1.Parity = Parity.None
        Form1.SerialPort1.StopBits = StopBits.One
        Form1.SerialPort1.Handshake = Handshake.None
        Form1.SerialPort1.Encoding = System.Text.Encoding.Default
        'SerialPort1.DtrEnable = True
        Form1.SerialPort1.ReadTimeout = 10000
        Form1.SerialPort1.Open()
        Form1.SerialPort1.Write("0")
        'Weight.Port_Num = ComboBox2.Text
        Weight.SerialPort1.Close()
        Weight.SerialPort1.PortName = ComboBox2.Text 'com port sa arduino
        Weight.SerialPort1.BaudRate = "9600"
        Weight.SerialPort1.DataBits = 8
        Weight.SerialPort1.Parity = Parity.None
        Weight.SerialPort1.StopBits = StopBits.One
        Weight.SerialPort1.Handshake = Handshake.None
        Weight.SerialPort1.Encoding = System.Text.Encoding.Default
        'SerialPort1.DtrEnable = True
        Weight.SerialPort1.ReadTimeout = 10000
        Weight.SerialPort1.Open()
        'Form1.SerialPort1.Write("0")
        Loading.button = 1
```

```
            Me.Close()
        Catch ex As Exception
            MessageBox.Show("PLEASE TRY  AGAIN")
        End Try
    End Sub
    Private Sub Button2_Click(sender As Object, e As EventArgs) Handles Button2.Click
        'Chart.Close()
        Loading.Close()
        Me.Close()
    End Sub
    Private Sub Label2_Click(sender As Object, e As EventArgs) Handles Label2.Click
    End Sub
End Class
Public  Class  Weight
    Dim ABW As Decimal
    Dim n As Integer
    Dim Position As Integer = 1
    Dim Num As Integer = 0
    Dim a As Integer = 0
    Dim sum As Integer
    Dim value1 As Decimal
    Dim value2 As Decimal
    Dim value3 As Decimal
    Dim age As Decimal = 0
    Dim weight As Decimal = 0

    Private Sub Button1_Click(sender As Object, e As EventArgs) Handles btnWeight.Click
        If Label5.Visible = False Then
            Label5.Text  =  Shrimp_Weight.Text
            Label5.Visible = True
            Shrimp_Weight.Text = ""
            Num = Num + Convert.ToDecimal(Label5.Text)
```

```
    weight = Convert.ToDecimal(Label5.Text)
    Label50.Visible = True
    Label50.Text = DOC(age)
ElseIf Label12.Visible = False Then
    Label12.Text = Shrimp_Weight.Text
    Label12.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label12.Text)
    weight = Convert.ToDecimal(Label12.Text)
    Label51.Visible = True
    Label51.Text = DOC(age)
ElseIf Label14.Visible = False Then
    Label14.Text = Shrimp_Weight.Text
    Label14.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label14.Text)
    weight = Convert.ToDecimal(Label14.Text)
    Label52.Visible = True
    Label52.Text = DOC(age)

ElseIf Label16.Visible = False Then
    Label16.Text = Shrimp_Weight.Text
    Label16.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label16.Text)
    weight = Convert.ToDecimal(Label16.Text)
    Label53.Visible = True
    Label53.Text = DOC(age)
ElseIf Label18.Visible = False Then
    Label18.Text = Shrimp_Weight.Text
    Label18.Visible = True
    Shrimp_Weight.Text  = ""
```

```
    Num = Num + Convert.ToDecimal(Label18.Text)
    weight = Convert.ToDecimal(Label18.Text)
    Label54.Visible = True
    Label54.Text = DOC(age)
ElseIf Label20.Visible = False Then
    Label20.Text = Shrimp_Weight.Text
    Label20.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label20.Text)
    weight = Convert.ToDecimal(Label20.Text)
    Label55.Visible = True
    Label55.Text = DOC(age)
ElseIf Label22.Visible = False Then
    Label22.Text = Shrimp_Weight.Text
    Label22.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label22.Text)
    weight = Convert.ToDecimal(Label22.Text)
    Label56.Visible = True
    Label56.Text = DOC(age)
ElseIf Label24.Visible = False Then
    Label24.Text = Shrimp_Weight.Text
    Label24.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label24.Text)
    weight = Convert.ToDecimal(Label24.Text)
    Label57.Visible = True
    Label57.Text = DOC(age)
ElseIf Label26.Visible = False Then
    Label26.Text = Shrimp_Weight.Text
    Label26.Visible = True
    Shrimp_Weight.Text  = ""
```

```
    Num = Num + Convert.ToDecimal(Label26.Text)
    weight = Convert.ToDecimal(Label26.Text)
    Label58.Visible = True
    Label58.Text = DOC(age)
ElseIf Label28.Visible = False Then
    Label28.Text = Shrimp_Weight.Text
    Label28.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label28.Text)
    weight = Convert.ToDecimal(Label28.Text)
    Label59.Visible = True
    Label59.Text = DOC(age)
ElseIf Label30.Visible = False Then
    Label30.Text = Shrimp_Weight.Text
    Label30.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label30.Text)
    weight = Convert.ToDecimal(Label30.Text)
    Label60.Visible = True
    Label60.Text = DOC(age)
ElseIf Label32.Visible = False Then
    Label32.Text = Shrimp_Weight.Text
    Label32.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label32.Text)
    weight = Convert.ToDecimal(Label32.Text)
    Label61.Visible = True
    Label61.Text = DOC(age)
ElseIf Label34.Visible = False Then
    Label34.Text = Shrimp_Weight.Text
    Label34.Visible = True
    Shrimp_Weight.Text = ""
```

```
    Num = Num + Convert.ToDecimal(Label34.Text)
    weight = Convert.ToDecimal(Label34.Text)
    Label62.Visible = True
    Label62.Text = DOC(age)
ElseIf Label36.Visible = False Then
    Label36.Text = Shrimp_Weight.Text
    Label36.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label36.Text)
    weight = Convert.ToDecimal(Label36.Text)
    Label63.Visible = True
    Label63.Text = DOC(age)

ElseIf Label38.Visible = False Then
    Label38.Text = Shrimp_Weight.Text
    Label38.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label38.Text)
    weight = Convert.ToDecimal(Label38.Text)
    Label64.Visible = True
    Label64.Text = DOC(age)
ElseIf Label40.Visible = False Then
    Label40.Text = Shrimp_Weight.Text
    Label40.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label40.Text)
    weight = Convert.ToDecimal(Label40.Text)
    Label65.Visible = True
    Label65.Text = DOC(age)
ElseIf Label42.Visible = False Then
    Label42.Text = Shrimp_Weight.Text
    Label42.Visible = True
```

```
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label42.Text)
    weight = Convert.ToDecimal(Label42.Text)
    Label66.Visible = True
    Label66.Text = DOC(age)
ElseIf Label44.Visible = False Then
    Label44.Text = Shrimp_Weight.Text
    Label44.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label44.Text)
    weight = Convert.ToDecimal(Label44.Text)
    Label67.Visible = True
    Label67.Text = DOC(age)
ElseIf Label46.Visible = False Then
    Label46.Text = Shrimp_Weight.Text
    Label46.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label46.Text)
    weight = Convert.ToDecimal(Label46.Text)
    Label68.Visible = True
    Label68.Text = DOC(age)
ElseIf Label48.Visible = False Then
    Label48.Text = Shrimp_Weight.Text
    Label48.Visible = True
    Shrimp_Weight.Text = ""
    Num = Num + Convert.ToDecimal(Label48.Text)
    weight = Convert.ToDecimal(Label48.Text)
    Label69.Visible = True
    Label69.Text = DOC(age)
Else
    Shrimp_Weight.Enabled = False
    btnWeight.Enabled = False
```

```
    End If
ABW = Num / 20
    Label8.Text = ABW
End Sub
Function DOC(ByVal age As Decimal) As Decimal
    ' local variable declaration */
    'Dim result As Integer

    If weight >= 3 And weight <= 3.74 Then
        age = "30"
    ElseIf weight >= 3.75 And weight <= 5.24 Then
        age = "40"
    ElseIf weight >= 5.25 And weight <= 6.9 Then
        age = "50"
    ElseIf weight >= 7 And weight <= 8.9 Then
        age = "60"
    ElseIf weight >= 9 And weight <= 11.4 Then
        age = "70"
    ElseIf weight >= 11.5 And weight <= 14.4 Then
        age = "80"
    ElseIf weight >= 14.5 And weight <= 17.4 Then
        age = "90"
    ElseIf weight >= 17.5 And weight <= 19.9 Then
        age = "100"
    ElseIf weight >= 20 And weight <= 21.9 Then
        age = "110"
    ElseIf weight >= 22 And weight <= 23.9 Then
        age = "120"
    ElseIf weight >= 24 And weight <= 25 Then
        age = "130"
    End If
    DOC = age
```

```
End Function
Private Sub Timer1_Tick(sender As Object, e As EventArgs) Handles Timer1.Tick
  Dim st As String
  st = TextBox2.Text + "," + "," + "," + ""
  Dim somestring() As String
  somestring = st.Split(New Char() {","c})
  Label7.Text = somestring(2)
  If Label7.Text = "" Then
    Label7.Text = value1
  Else
    Try
      value1 = Convert.ToDecimal(Label7.Text)
    Catch ex As Exception
      value1 = value1
    End Try
  End If
  Shrimp_Weight.Text = Label7.Text
  Form1.Water_Temp.Text = somestring(0)
  If Form1.Water_Temp.Text = "" Then
    Form1.Water_Temp.Text = value2
  Else
    Try
      value2  =  Convert.ToDecimal(Form1.Water_Temp.Text)
    Catch ex As Exception
      value2 = value2
    End Try
  End If
  If value3 < 28 Then
    Form1.label2.Text = "below normal"
  ElseIf value3 > 33 Then
    Form1.label2.Text = "above normal"
  Else Form1.label2.Text = "normal"
```

```
        End If
        Form1.Ph_Level.Text = somestring(1)
        If Form1.Ph_Level.Text = "" Then
            Form1.Ph_Level.Text = value3
        Else
            Try
                value3  =  Convert.ToDecimal(Form1.Ph_Level.Text)
            Catch ex As Exception
                value3 = value3
            End Try
        End If
        If value2 < 7.4 Then
            Form1.label4.Text = "below normal"
        ElseIf value2 > 7.9 Then
            Form1.label4.Text  =  "above  normal"
        Else
            Form1.label4.Text  =  "normal"
        End If
        TextBox2.Text = ""
    End Sub
    Private Sub DataReceived(ByVal sender As Object, ByVal e As SerialDataReceivedEventArgs)
Handles SerialPort1.DataReceived
        Try
            Dim mydata As String = ""
            mydata = Me.SerialPort1.ReadExisting()
            If TextBox2.InvokeRequired Then
                TextBox2.Invoke(DirectCast(Sub() TextBox2.Text &= mydata, MethodInvoker))
            Else
                TextBox2.Text &= mydata
            End If
        Catch ex As Exception
            MessageBox.Show(ex.Message)
```

```
        End Try
    End Sub
    Private Sub Done_Click(sender As Object, e As EventArgs) Handles Done.Click
        If Population.Text = "" Then
            MessageBox.Show("PLEASE  ENTER  NUMBER  OF  POPULATION")
        Else
            Form1.Label29.Text = ABW
            Form1.Label30.Text = Population.Text
            Me.Hide()
        End If
    End Sub

    Private Sub Shrimp_Weight_TextChanged(sender As Object, e As EventArgs) Handles
Shrimp_Weight.TextChanged
    End Sub
    Private Sub Population_TextChanged(sender As Object, e As EventArgs) Handles
Population.TextChanged
    End Sub
End Class
```

Arduino Uno Code

```
#include <HX711_ADC.h>
#include <EEPROM.h>
#include <OneWire.h>
#include <U8glib.h>
#include <stdlib.h>
#include <DallasTemperature.h>
String Final_Values1;
//**************LOADCELL***************
const int HX711_dout = 4; //mcu > HX711 dout pin
const int HX711_sck = 5; //mcu > HX711 sck pin
//HX711 constructor:
HX711_ADC LoadCell(HX711_dout, HX711_sck);
const int calVal_eepromAdress = 0;
long t;
float final1;
//****************WaterTemp**************
#define ONE_WIRE_BUS 3
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature water_temp_probe(&oneWire);
//const char DEGREE_SYMBOL[] = { 0xB0, '\0' };
double water_temp=0;
double ideal_min_temperature = 28.00;
double ideal_max_temperature = 33.00;
//***************Ph****************
#define PHSensorPin A0
int buf[10],temp;
unsigned long int avgValue;
void setup() {
Serial.begin(9600); delay(10);
  //Serial.println();
  //Serial.println("Starting...");
```

```
  water_temp_probe.begin();
  LoadCell.begin();
  float calibrationValue; // calibration value (see example file "Calibration.ino")
  calibrationValue = 696.0; // uncomment this if you want to set the calibration value in the sketch
#if defined(ESP8266)|| defined(ESP32)
  //EEPROM.begin(512); // uncomment this if you use ESP8266/ESP32 and want to fetch the calibration value from eeprom
#endif
  EEPROM.get(calVal_eepromAdress, calibrationValue); // uncomment this if you want to fetch the calibration value from eeprom
  long stabilizingtime = 2000; // preciscion right after power-up can be improved by adding a few seconds of stabilizing time
  boolean _tare = true; //set this to false if you don't want tare to be performed in the next step
  LoadCell.start(stabilizingtime, _tare);
  if  (LoadCell.getTareTimeoutFlag())  {
    //Serial.println("Timeout, check MCU>HX711 wiring and pin designations");
    while (1);
  }
  else {
    LoadCell.setCalFactor(calibrationValue); // set calibration value (float)
    //Serial.println("Startup is complete");
  }
}
void loop() {
  //for(int a = 0 ; a<=10000 ; a++)
  static boolean newDataReady = 0;
  const int serialPrintInterval = 0; //increase value to slow down serial print activity
  // check for new data/start next conversion:
  if (LoadCell.update()) newDataReady = true;
  // get smoothed value from the dataset:
  if (newDataReady) {
    if (millis() > t + serialPrintInterval) {
      float i = LoadCell.getData();
```

```
      //Serial.print("Load_cell output val: ");
      //Serial.println(i);
      final1 = i;
      newDataReady = 0;
      t = millis();
    }
  }
  // receive command from serial terminal, send 't' to initiate tare operation:
  if (Serial.available() > 0) {
    float i;
    char inByte = Serial.read();
    if (inByte == 't') LoadCell.tareNoDelay();
  }
  // check if last tare operation is complete:
  if (LoadCell.getTareStatus() == true) {
    //Serial.println("Tare complete");
  }
//******************WaterTemp****************
  water_temp_probe.requestTemperatures();
  water_temp=water_temp_probe.getTempCByIndex(0);
  //Serial.print(water_temp);
//***************Ph****************
for(int i=0;i<10;i++)       //Get 10 sample value from the sensor for smooth the value
  {
    buf[i]=analogRead(PHSensorPin);
    //delay(10);
  }
  for(int i=0;i<9;i++)        //sort the analog from small to large
  {
    for(int j=i+1;j<10;j++)
    {
      if(buf[i]>buf[j])
```

```
    {
      temp=buf[i];
      buf[i]=buf[j];
      buf[j]=temp;
    }
  }
 }
 avgValue=0;
 for(int i=2;i<8;i++)                    //take the average value of 6 center sample
 avgValue+=buf[i];
 float phValue=(float)avgValue*5.0/1024/6; //convert the analog into millivolt
 phValue=3.5*phValue;                      //convert the millivolt into pH value
 //Serial.print("ph: ");
 Final_Values1 = Final_Values1  + water_temp + "," + phValue + "," + final1 + ",";
 Serial.println(Final_Values1);
 Final_Values1 = "";
 delay(100); }
```

Arduino Mega Code

```
#include <OneWire.h>
#include <DallasTemperature.h>
#include <U8glib.h>
#include <stdlib.h>
#include <HX711_ADC.h>
#include <EEPROM.h>
#include<Servo.h>
String Final_Values;
#define  relay  8//****************************
//**********ULTRASONIC SENSOR**********
#define echoPin 4
#define trigPin 5
//**********LOAD  CELL**********
```

```
const int HX711_dout = 7; //mcu > HX711 dout pin
const int HX711_sck = 6; //mcu > HX711 sck pin
HX711_ADC LoadCell(HX711_dout, HX711_sck);
const int calVal_eepromAdress = 0;
long t;
float final_Weight1;
//**********ULTRASONIC SENSOR**********
long duration;
int distance;
//**********SERVO   MOTOR**********
Servo S_Motor1;
Servo S_Motor2;
Servo S_Motor3;
int var = 0;
void setup()
{
 pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(relay, OUTPUT);
  digitalWrite(relay, HIGH);
  S_Motor1.attach(13);
  S_Motor1.write(125);
  S_Motor2.attach(12);
  S_Motor2.write(150);
  S_Motor3.attach(11);
  S_Motor3.write(90);
  Serial.begin(57600);
  LoadCell.begin();
  float calibrationValue; // calibration value (see example file "Calibration.ino")
  calibrationValue = 696.0; // uncomment this if you want to set the calibration value in the
sketch
  #if defined(ESP8266)|| defined(ESP32)
```

```
  //EEPROM.begin(512); // uncomment this if you use ESP8266/ESP32 and want to fetch the calibration value from eeprom
  #endif
  EEPROM.get(calVal_eepromAdress, calibrationValue); // uncomment this if you want to fetch the calibration value from eeprom
  long stabilizingtime = 2000; // preciscion right after power-up can be improved by adding a few seconds of stabilizing time
  boolean _tare = true; //set this to false if you don't want tare to be performed in the next step
  LoadCell.start(stabilizingtime, _tare);
  if  (LoadCell.getTareTimeoutFlag())  {
    //Serial.println("Timeout, check MCU>HX711 wiring and pin designations");
    while (1);
  }
  else {
    LoadCell.setCalFactor(calibrationValue); // set calibration value (float)
    //Serial.println("Startup is complete");
  }
}
void loop()
{
  //**********ULTRASONIC   SENSOR**********
   //Clears the trigPin condition
 digitalWrite(trigPin, LOW);
 delayMicroseconds(2);
   //Sets the trigPin HIGH (ACTIVE) for 10 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
   //Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
   //Calculating the distance
  distance = duration * 0.034 / 2; // Speed of sound wave divided by 2 (go and back)
   //Displays the distance on the Serial Monitor
```

```
if (var == 1) //*********************
{
 S_Motor3.write(30);
 delay(250);
}
if (var == 1)//*********************
{
 S_Motor3.write(90);
 delay(250);
}
//**********LOAD CELL**********
for(int a = 0 ; a<=1000 ; a++)
{
 static boolean newDataReady = 0;
 const int serialPrintInterval = 0; //increase value to slow down serial print activity
 //check for new data/start next conversion:
 if (LoadCell.update()) newDataReady = true;
// get smoothed value from the dataset:
 if (newDataReady)
 {
  if (millis() > t + serialPrintInterval)
  {
   float i = LoadCell.getData();
   //Serial.print("Load_cell output val: ");
   //Serial.println(i);
  final_Weight1 = i;
  newDataReady = 0;
  t = millis();
  }
 }
  }
  if (var == 1)//*********************
```

```
{
  S_Motor3.write(150);
  delay(250);
}
int val = Serial.read() - '0';
if(val == 1) // Fist Motor_Opening
{
  S_Motor1.write(115);
  var = 1;
}
else if(val == 2 ) // Fist Motor_Closing
{
   S_Motor1.write(125);
   S_Motor3.write(90);
   var = 0;
}
else if (val == 3) //Second Motor_Opening
{
  S_Motor2.write(55);
  digitalWrite(relay, LOW);
  delay(100);
}
else if (val == 4) //Second Motor_Closing
{
  S_Motor2.write(150);
  digitalWrite(relay,  HIGH);
}
if (var == 1)//**********************
{
  S_Motor3.write(90);
  delay(250);
}
```

```
distance = 1;
 Final_Values = Final_Values + distance + "," + final_Weight1 + ",";
    //Final_Values = Final_Values + distance + "," + phValue + ",";
  Serial.println(Final_Values);
Final_Values = "";
if (var != 1)
  {
  delay(500);
  } }
```

APPENDIX E

DATA GATHERING

The researchers will record *L. vannamei* shrimp weights with the corresponding days-old, the feeding rate, the average weight, and the amount of feed in each pond every after 7 days. Also, the researchers will record the water level, temperature, and the pH value for the water quality of the pond every after 7 days. These can be seen on the user interface of the software provided in the system that will display on the laptop, and the feeding mechanism in pond 1 will be automated. While in pond 2, all the processes will be done manually. Since the day 0 to day 20 shrimp's weight could not be seen using the weighing apparatus, the researchers began collecting data on day 21. Table 2 shows the blind feeding data of pond 1 and 2.1 to 2.6 shows how the researchers will gather the data using the feeding device while table 3 shows the blind feeding data of pond 2 and 3.1 to 3.6 shows how the researchers will gather the data using manual feeding method. Table 4 shows the total feeding distribution per day of the feeding device.

Table 2. Data Gathering of Pond 1 from Day 0 – Day 20 Blind Feeding

<table>
<tr><td rowspan="3">Date:
June 11, 2021</td><td colspan="7">DAY 21
Water level: 1 meter pH value: 7.08 at 7 AM Temperature: 19.23°C at 7 AM
Age: 21 days 7.29 at 2 PM 25.37°C at 2 PM
7.24 at 10 PM 21.02°C at 10 PM</td></tr>
<tr><td colspan="7">Blind Feeding</td></tr>
<tr><td rowspan="2">Weight
(g)</td><td rowspan="2">Frequency</td><td rowspan="2">Feeding rate (%)</td><td colspan="3">Calculated total feeds per Distribution (g)
7 AM | 2 PM | 10 PM</td><td rowspan="2">Calculated total feeds per day (g)</td></tr>
<tr><td>Samples</td><td colspan="3"></td></tr>
<tr><td>Shrimp 1</td><td>3.3</td><td>3x</td><td>8.0</td><td>17.12</td><td>17.12</td><td>17.12</td><td>51.36</td></tr>
<tr><td>Shrimp 2</td><td>2.5</td><td>3x</td><td>8.0</td><td>17.12</td><td>17.12</td><td>17.12</td><td>51.36</td></tr>
<tr><td>Shrimp 3</td><td>3.1</td><td>3x</td><td>8.0</td><td>17.12</td><td>17.12</td><td>17.12</td><td>51.36</td></tr>
</table>

Shrimp 4	**3.6**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 5	**2.8**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 6	**4.4**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 7	**3.1**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 8	**2.8**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 9	**3.2**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 10	**4.2**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 11	**2.6**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 12	**2.3**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 13	**4.2**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 14	**3.3**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 15	**2.1**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 16	**3.7**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 17	**3.2**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 18	**2.5**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 19	**2.7**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**
Shrimp 20	**4.7**	**3x**	**8.0**	**17.12**	**17.12**	**17.12**	**51.36**

Calculation of Average Body Weight for the Next Sampling

Formula: $\mathbf{ABW_{TOTAL}} = \dfrac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \dfrac{64.3}{20}$

$\mathbf{ABW_{TOTAL}} = \underline{\mathbf{3.21}}$

Table 2.1 Data Gathering of Pond 1 – Feeding Device (Day 29)

Date: June 19, 2021	**DAY 29** **Water level:** 1 meter **pH value:** 7.17 at 7 AM, 7.40 at 2 PM, 7.31 at 10 PM **Temperature:** 18.24°C at 7 AM, 26.04°C at 2 PM, 22.05°C at 10 PM **Age:** 29 days						
	Feeding Device						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Calculated total feeds per Distribution (g)** **7 AM | 2 PM | 10 PM**			**Calculated total feeds per day (g)**
Shrimp 1	**6.5**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 2	**5.7**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 3	**4.5**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 4	**5.5**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 5	**6.7**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 6	**5.8**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 7	**4.1**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 8	**5.9**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 9	**5.3**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 10	**6.0**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 11	**5.2**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 12	**6.6**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 13	**5.0**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 14	**6.8**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 15	**4.9**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 16	**5.9**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 17	**6.0**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 18	**6.2**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**
Shrimp 19	**4.8**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**

Shrimp 20	**5.6**	**3x**	**4.5**	**16.95**	**16.95**	**16.95**	**50.85**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{113}{20}$

ABW_{TOTAL} = **5.65**

Table 2.2 Data Gathering of Pond 1 – Feeding Device (Day 37)

Date: June 27, 2021	DAY 37						
	Water level: 1 meter **Age:** 37 days **pH value:** 7.11 at 7 AM 7.18 at 2 PM 7.38 at 10 PM **Temperature:** 17.56°C at 7 AM 23.34°C at 2 PM 20.24°C at 10 PM						
	Feeding Device						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Calculated total feeds per Distribution (g)** 7 AM	2 PM	10 PM	**Calculated total feeds per day (g)**
Shrimp 1	**8.2**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 2	**7.8**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 3	**9.1**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 4	**7.1**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 5	**9.2**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 6	**7.9**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 7	**8.1**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 8	**6.9**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 9	**9.0**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 10	**7.6**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**

Shrimp 11	**9.4**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 12	**8.7**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 13	**8.3**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 14	**9.3**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 15	**8.0**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 16	**9.4**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 17	**7.0**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 18	**8.8**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 19	**8.5**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**
Shrimp 20	**9.0**	**3x**	**4.0**	**22.29**	**22.29**	**22.29**	**66.88**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{167.3}{20}$

ABW_{TOTAL} = 8.36

Table 2.3 Data Gathering of Pond 1 – Feeding Device (Day 45)

Date: July 05, 2021	DAY 45 **Water level:** 1 meter **Age:** 45 days **pH value:** 7.19 at 7 AM, 7.10 at 2 PM, 7.18 at 10 PM **Temperature:** 18.49°C at 7 AM, 27.34°C at 2 PM, 24.19°C at 10 PM						
	Feeding Device						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Calculated total feeds per Distribution (g) 7 AM**	**2 PM**	**10 PM**	**Calculated total feeds per day (g)**
Shrimp 1	**12.7**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 2	**10.8**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 3	**12.3**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 4	**11.0**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 5	**13.0**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 6	**11.5**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 7	**12.8**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 8	**10.9**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 9	**13.0**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 10	**9.9**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 11	**10.1**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 12	**12.4**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 13	**13.5**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 14	**10.5**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 15	**11.6**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 16	**11.9**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**

Shrimp 17	**12.1**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 18	**11.0**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 19	**13.1**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**
Shrimp 20	**12.8**	**3x**	**3.2**	**25.26**	**25.26**	**25.26**	**75.78**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{236.9}{20}$

$ABW_{TOTAL} = \underline{11.84}$

Table 2.4 Data Gathering of Pond 1 – Feeding Device (Day 53)

Date: July 13, 2021	**DAY 53** **Water level:** 1 meter **pH value:** 7.15 at 7 AM **Temperature:** 17.10°C at 7 AM **Age:** 53 days 7.12 at 2 PM 19.34°C at 2 PM 7.19 at 10 PM 22.15°C at 10 PM						
	Feeding Device						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Calculated total feeds per Distribution (g)** 7 AM	2 PM	10 PM	**Calculated total feeds per day (g)**
Shrimp 1	**14.8**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 2	**12.4**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 3	**16.4**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 4	**14.3**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 5	**12.0**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 6	**15.0**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 7	**14.7**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**

Shrimp 8	**13.0**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 9	**12.7**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 10	**11.4**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 11	**15.5**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 12	**14.2**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 13	**12.6**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 14	**16.0**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 15	**13.7**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 16	**11.1**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 17	**15.7**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 18	**16.2**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 19	**13.4**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**
Shrimp 20	**15.5**	**3x**	**3.2**	**29.93**	**29.93**	**29.93**	**89.79**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{280.6}{20}$

$ABW_{TOTAL} = \underline{14.03}$

Table 2.5 Data Gathering of Pond 1 – Feeding Device (Day 61)

Date: July 21, 2021	DAY 61 **Water level:** 1 meter **Age:** 61 days **pH value:** 7.07 at 7 AM, 7.16 at 2 PM, 7.20 at 10 PM **Temperature:** 16.23°C at 7 AM, 26.36°C at 2 PM, 23.19°C at 10 PM						
	Feeding Device						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Calculated total feeds per Distribution (g)** 7 AM	2 PM	10 PM	**Calculated total feeds per day (g)**
Shrimp 1	**17.7**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 2	**18.2**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 3	**15.7**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 4	**16.9**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 5	**19.3**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 6	**17.0**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 7	**17.1**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 8	**16.5**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 9	**16.2**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 10	**16.9**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 11	**17.4**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 12	**17.8**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 13	**17.3**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 14	**16.3**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 15	**16.8**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**

Shrimp 16	**16.0**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 17	**18.0**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 18	**17.5**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 19	**17.1**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**
Shrimp 20	**18.2**	**3x**	**2.80**	**32.09**	**32.09**	**32.09**	**96.26**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \dfrac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \dfrac{343.9}{20}$

$ABW_{TOTAL} = \underline{17.19}$

Table 2.6 Data Gathering of Pond 1 – Feeding Device (Day 70)

Date: July 30, 2021	**DAY 70** — **Water level:** 1 meter **Age:** 70 days **pH value:** **Temperature:**						
	Feeding Device						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Calculated total feeds per Distribution (g)** 7 AM	2 PM	10 PM	**Calculated total feeds per day (g)**
Shrimp 1	**20.4**	-	-	-	-	-	-
Shrimp 2	**17.9**	-	-	-	-	-	-
Shrimp 3	**21.5**	-	-	-	-	-	-
Shrimp 4	**18.6**	-	-	-	-	-	-
Shrimp 5	**22.5**	-	-	-	-	-	-
Shrimp 6	**20.3**	-	-	-	-	-	-

Shrimp 7	**19.0**	-	-	-	-	-	-
Shrimp 8	**18.8**	-	-	-	-	-	-
Shrimp 9	**23.3**	-	-	-	-	-	-
Shrimp 10	**17.2**	-	-	-	-	-	-
Shrimp 11	**22.7**	-	-	-	-	-	-
Shrimp 12	**19.2**	-	-	-	-	-	-
Shrimp 13	**17.6**	-	-	-	-	-	-
Shrimp 14	**16.8**	-	-	-	-	-	-
Shrimp 15	**18.2**	-	-	-	-	-	-
Shrimp 16	**22.5**	-	-	-	-	-	-
Shrimp 17	**20.12**	-	-	-	-	-	-
Shrimp 18	**21.8**	-	-	-	-	-	-
Shrimp 19	**17.4**	-	-	-	-	-	-
Shrimp 20	**24.5**	-	-	-	-	-	-

Calculation of Average Body Weight for the Next Sampling

Formula: $\mathbf{ABW_{TOTAL}} = \dfrac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \dfrac{400.32}{20}$

$\mathbf{ABW_{TOTAL}} = \underline{\mathbf{20.01}}$

Table 3. Data Gathering of Pond 2 from Day 0 – Day 20 Blind Feeding

	DAY 21 **Age:** <u>21 days</u>

Date: June 11, 2021	Blind Feeding						
	Weight	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution**			**Number of total feeds per day (g)**
Samples	**(g)**			**7 AM | 2 PM | 10 PM**			
Shrimp 1	**3.4**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 2	**2.7**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 3	**2.6**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 4	**4.2**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 5	**3.3**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 6	**3.1**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 7	**2.1**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 8	**4.3**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 9	**3.2**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 10	**2.7**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 11	**2.3**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 12	**4.2**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 13	**3.3**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 14	**4.7**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 15	**3.1**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 16	**2.5**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 17	**3.2**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 18	**3.7**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 19	**2.8**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**
Shrimp 20	**2.3**	**3x**	**8.0**	**17.01**	**17.01**	**17.01**	**51.04**

Calculation of Average Body Weight for the Next Sampling

Formula: $$ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{63.7}{20}$$

$$ABW_{TOTAL} = 3.19$$

Table 3.1 Data Gathering of Pond 2 – Manual Feeding (Day 29)

Date: June 19, 2021	DAY 29 Age: 29 days						
	Manual Feeding						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution** **7 AM | 2 PM | 10 PM**			**Number of total feeds per day (g)**
Shrimp 1	**5.2**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 2	**5.4**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 3	**4.9**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 4	**6.7**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 5	**5.9**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 6	**4.8**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 7	**6.5**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 8	**6.0**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 9	**5.0**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 10	**5.6**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 11	**5.9**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**

Shrimp 12	**6.8**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 13	**6.2**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 14	**4.5**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 15	**6.3**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 16	**5.3**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 17	**5.9**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 18	**5.5**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 19	**4.0**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**
Shrimp 20	**5.8**	**3x**	**4.5**	**16.83**	**16.83**	**16.83**	**50.49**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{112.2}{20}$

$ABW_{TOTAL} = \underline{5.61}$

Table 3.2 Data Gathering of Pond 2 – Manual Feeding (Day 37)

Date: June 27, 2021	**DAY 37** Age: 37 days						
	Manual Feeding						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution (g) 7 AM | 2 PM | 10 PM**			**Number of total feeds per day (g)**
Shrimp 1	**9.0**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 2	**7.6**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**

Shrimp 3	**9.4**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 4	**7.1**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 5	**9.3**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 6	**7.0**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 7	**8.2**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 8	**8.9**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 9	**8.3**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 10	**7.8**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 11	**8.1**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 12	**9.2**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 13	**8.0**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 14	**6.9**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 15	**8.8**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 16	**9.0**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 17	**9.2**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 18	**8.2**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 19	**8.7**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**
Shrimp 20	**7.9**	**3x**	**4.0**	**22.21**	**22.21**	**22.21**	**66.64**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{166.6}{20}$

$ABW_{TOTAL} = \underline{8.33}$

Table 3.3 Data Gathering of Pond 2 – Manual Feeding (Day 45)

Date: July 05, 2021	DAY 45 Age: 45 days						
	Manual Feeding						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution (g)** **7 AM | 2 PM | 10 PM**			**Number of total feeds per day (g)**
Shrimp 1	**11.0**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 2	**12.9**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 3	**12.8**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 4	**11.9**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 5	**13.0**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 6	**12.4**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 7	**9.9**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 8	**11.6**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 9	**10.5**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 10	**12.3**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 11	**12.1**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 12	**10.9**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 13	**11.0**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 14	**10.8**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 15	**13.5**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 16	**11.6**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 17	**11.2**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 18	**12.8**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**

Shrimp 19	**10.1**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**
Shrimp 20	**12.1**	**3x**	**3.2**	**25.0**	**25.0**	**25.0**	**75.01**

Calculation of Average Body Weight for the Next Sampling

Formula: $\mathbf{ABW_{TOTAL}} = \dfrac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \dfrac{234.4}{20}$

$\mathbf{ABW_{TOTAL}} = \underline{\mathbf{11.72}}$

Table 3.4 Data Gathering of Pond 2 – Manual Feeding (Day 53)

Date: July 13, 2021	**DAY 53** Age: 53 days						
	Manual Feeding						
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution (g)** 7 AM	2 PM	10 PM	**Number of total feeds per day (g)**
Shrimp 1	**11.4**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 2	**12.6**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 3	**15.3**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 4	**14.3**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 5	**15.5**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 6	**13.4**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 7	**14.7**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 8	**16.0**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 9	**14.8**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**

Shrimp 10	**15.5**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 11	**12.0**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 12	**14.2**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 13	**13.1**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 14	**13.7**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 15	**12.3**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 16	**16.2**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 17	**15.0**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 18	**11.0**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 19	**16.4**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**
Shrimp 20	**12.5**	**3x**	**3.20**	**29.87**	**29.87**	**29.87**	**89.6**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{279.9}{20}$

$ABW_{TOTAL} = \underline{14.0}$

Table 3.5 Data Gathering of Pond 2 – Manual Feeding (Day 61)

Date: July 21, 2021	**DAY 61** **Age:** 61 days				
	Manual Feeding				
Samples	**Weight (g)**	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution (g)** **7 AM | 2 PM | 10 PM**	**Number of total feeds per day (g)**

Shrimp 1	**15.5**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 2	**17.4**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 3	**16.5**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 4	**15.9**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 5	**16.3**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 6	**16.9**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 7	**17.1**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 8	**17.9**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 9	**17.7**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 10	**16.9**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 11	**18.1**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 12	**17.1**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 13	**17.4**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 14	**18.2**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 15	**16.2**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 16	**17.3**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 17	**19.3**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 18	**16.8**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 19	**17.6**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**
Shrimp 20	**17.0**	**3x**	**2.80**	**32.03**	**32.03**	**32.03**	**96.10**

Calculation of Average Body Weight for the Next Sampling

Formula: $$ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{343.1}{20}$$

ABW_{TOTAL} = <u>17.16</u>

Table 3.6 Data Gathering of Pond 2 – Manual Feeding (Day 70)

Date: July 30, 2021	**DAY 70** **Water level:_____** **pH value:** **Temperature:** **Age:** <u>70 days</u>						
	Manual Feeding						
Samples	**Weight** **(g)**	**Frequency**	**Feeding rate (%)**	**Number of total feeds per Distribution (g)** **7 AM | 2 PM | 10 PM**			**Number of total feeds per day (g)**
Shrimp 1	**22.4**	-	-	-	-	-	-
Shrimp 2	**19.2**	-	-	-	-	-	-
Shrimp 3	**23.3**	-	-	-	-	-	-
Shrimp 4	**20.3**	-	-	-	-	-	-
Shrimp 5	**17.6**	-	-	-	-	-	-
Shrimp 6	**22.5**	-	-	-	-	-	-
Shrimp 7	**20.2**	-	-	-	-	-	-
Shrimp 8	**21.4**	-	-	-	-	-	-
Shrimp 9	**18.2**	-	-	-	-	-	-
Shrimp 10	**24.5**	-	-	-	-	-	-
Shrimp 11	**17.8**	-	-	-	-	-	-
Shrimp 12	**22.5**	-	-	-	-	-	-
Shrimp 13	**17.2**	-	-	-	-	-	-

Shrimp 14	**20.1**	**-**	**-**	**-**	**-**	**-**	**-**
Shrimp 15	**21.5**	**-**	**-**	**-**	**-**	**-**	**-**
Shrimp 16	**16.8**	**-**	**-**	**-**	**-**	**-**	**-**
Shrimp 17	**18.9**	**-**	**-**	**-**	**-**	**-**	**-**
Shrimp 18	**17.4**	**-**	**-**	**-**	**-**	**-**	**-**
Shrimp 19	**18.6**	**-**	**-**	**-**	**-**	**-**	**-**
Shrimp 20	**18.8**	**-**	**-**	**-**	**-**	**-**	**-**

Calculation of Average Body Weight for the Next Sampling

Formula: $ABW_{TOTAL} = \frac{\Sigma \text{ of total shrimp weight samples}}{\text{Number of shrimp samples}} = \frac{399.2}{20}$

$ABW_{TOTAL} = 19.96$

Table 4 Total Feed Distribution per day of feeding device (Day 21-70)

DATA OF THE FEEDING DEVICE							
Day of Culture (DoC)	Exact value (g)	Experimental values (g)					
		1st Distribution (g)	Percentage error (%)	2nd Distribution (g)	Percentage error (%)	3rd Distribution (g)	Percentage error (%)
Day 21	17.12	17.12	-	17.12	-	17.12	-
Day 22	17.12	17.12	-	17.12	-	17.12	-
Day 23	17.12	17.12	-	17.12	-	17.12	-
Day 24	17.12	17.12	-	17.12	-	17.12	-
Day 25	17.12	17.12	-	17.12	-	17.12	-
Day 26	17.12	17.12	-	17.12	-	17.12	-
Day 27	17.12	17.12	-	17.12	-	17.12	-
Day 28	17.12	17.12	-	17.12	-	17.12	-
Day 29	16.95	16.30	± 3.83	16.36	± 3.48	17.30	± 2.06
Day 30	16.95	16.23	± 4.25	16.33	± 3.66	16.66	± 1.71
Day 31	16.95	16.98	± 0.18	16.23	± 4.25	16.23	± 4.25
Day 32	16.95	17.57	± 3.66	16.70	± 1.47	16.78	± 1.00

Day 33	16.95	16.56	± 2.30	17.05	± 0.59	17.13	± 1.06
Day 34	16.95	17.50	± 3.24	17.24	± 1.71	17.21	± 1.53
Day 35	16.95	16.20	± 4.42	16.59	± 2.12	16.45	± 2.95
Day 36	16.95	17.08	± 0.77	17.10	± 0.88	17.03	± 0.47
Day 37	22.29	21.93	± 1.62	22.15	± 0.63	21.35	± 4.22
Day 38	22.29	22.45	± 0.72	22.43	± 0.63	21.79	± 2.24
Day 39	22.29	22.88	± 2.65	21.83	± 2.06	22.07	± 0.99
Day 40	22.29	21.56	± 3.28	22.21	± 0.36	21.94	± 1.57
Day 41	22.29	21.73	± 2.51	21.79	± 2.24	22.39	± 0.45
Day 42	22.29	22.10	± 0.85	22.10	± 0.85	21.69	± 2.69
Day 43	22.29	21.55	± 3.32	22.46	± 0.76	22.53	± 1.08
Day 44	22.29	22.83	± 2.42	21.50	± 3.54	22.05	± 1.08
Day 45	25.26	25.33	± 0.28	24.66	± 2.38	24.76	± 1.98
Day 46	25.26	24.88	± 1.50	24.88	± 1.50	25.33	± 0.28
Day 47	25.26	25.44	± 0.71	25.24	± 0.08	25.39	± 0.51
Day 48	25.26	25.05	± 0.83	24.77	± 1.94	24.85	± 1.62
Day 49	25.26	24.75	± 2.02	25.30	± 0.16	24.54	± 2.85
Day 50	25.26	25.21	± 0.20	25.43	± 0.67	24.77	± 1.94
Day 51	25.26	24.84	± 1.66	25.23	± 0.12	25.20	± 0.24
Day 52	25.26	25.77	± 2.02	24.95	± 1.23	25.65	± 1.54
Day 53	29.93	29.25	± 2.27	30.34	± 1.37	30.18	± 0.84
Day 54	29.93	30.10	± 0.57	29.05	± 2.94	30.44	± 1.70
Day 55	29.93	29.43	± 1.67	30.66	± 2.44	29.02	± 3.04
Day 56	29.93	29.55	± 1.27	29.90	± 0.10	29.85	± 0.27
Day 57	29.93	30.21	± 0.94	29.71	± 0.74	29.01	± 3.07
Day 58	29.93	29.66	± 0.90	30.55	± 2.07	29.00	± 3.11
Day 59	29.93	30.12	± 0.63	29.67	± 0.87	29.77	± 0.53
Day 60	29.93	29.33	± 2.00	29.16	± 2.57	30.19	± 0.87
Day 61	32.09	31.50	± 1.84	31.01	± 3.37	32.88	± 2.46
Day 62	32.09	32.44	± 1.09	31.23	± 2.68	31.04	± 3.27
Day 63	32.09	32.31	± 0.69	32.67	± 1.81	31.23	± 2.68
Day 64	32.09	31.15	± 2.93	31.05	± 3.24	33.01	± 2.87
Day 65	32.09	31.66	± 1.34	32.87	± 2.43	32.85	± 2.37
Day 66	32.09	32.02	± 0.22	32.99	± 2.80	31.67	± 1.31
Day 67	32.09	31.29	± 2.49	31.06	± 3.21	32.03	± 0.19
Day 68	32.09	31.06	± 3.21	32.03	± 0.19	31.97	± 0.37
Day 69	32.09	32.55	± 1.43	31.24	± 2.65	31.53	± 1.75
Day 70	32.09	31.33	± 2.37	31.52	± 1.78	31.20	± 2.77

DATA OF THE FEEDING DEVICE			
Day of Culture (DoC)	Total feed per day for Exact value (g)	Total feed per day for Experimental value (g)	Percentage error (%)
Day 21	17.12	17.12	-
Day 22	17.12	17.12	-

Day 23	17.12	17.12	-
Day 24	17.12	17.12	-
Day 25	17.12	17.12	-
Day 26	17.12	17.12	-
Day 27	17.12	17.12	-
Day 28	17.12	17.12	-
Day 29	50.85	49.96	± 1.75
Day 30	50.85	49.22	± 3.21
Day 31	50.85	49.44	± 2.77
Day 32	50.85	51.05	± 0.39
Day 33	50.85	50.74	± 0.22
Day 34	50.85	51.95	± 2.16
Day 35	50.85	49.24	± 3.17
Day 36	50.85	51.21	± 0.71
Day 37	66.88	65.43	± 2.15
Day 38	66.88	66.67	± 0.30
Day 39	66.88	66.78	± 0.13
Day 40	66.88	65.71	± 1.73
Day 41	66.88	65.91	± 1.44
Day 42	66.88	65.89	± 1.47
Day 43	66.88	66.54	± 0.49
Day 44	66.88	66.38	± 0.73
Day 45	75.78	74.75	± 1.36
Day 46	75.78	75.09	± 0.91
Day 47	75.78	76.07	± 0.38
Day 48	75.78	74.67	± 1.46
Day 49	75.78	74.59	± 1.57
Day 50	75.78	75.41	± 0.49
Day 51	75.78	75.27	± 0.67
Day 52	75.78	76.37	± 0.78
Day 53	89.79	89.77	± 0.02
Day 54	89.79	89.59	± 0.23
Day 55	89.79	89.11	± 0.76
Day 56	89.79	89.30	± 0.55
Day 57	89.79	88.93	± 0.96
Day 58	89.79	89.21	± 0.65
Day 59	89.79	89.56	± 0.26
Day 60	89.79	88.68	± 1.24
Day 61	96.26	95.39	± 0.91
Day 62	96.26	94.71	± 1.62
Day 63	96.26	96.21	± 0.06
Day 64	96.26	95.21	± 1.10
Day 65	96.26	97.38	± 1.15
Day 66	96.26	96.68	± 0.43
Day 67	96.26	94.38	± 1.96
Day 68	96.26	95.06	± 1.26
Day 69	96.26	95.32	± 0.99

Day 70	96.26	94.05	± 2.31

POND MONITORING DATA

	Day 21	Status	Day 29	Status	Day 37	Status	Day 45	Status	Day 53	Status	Day 61	Status	Day 70	Status
Water Temperature	27.83 °C	below normal	28.47 °C	normal	26.02 °C	below normal	29.95 °C	normal	24.43 °C	below normal	28.74 °C	normal	32.19 °C	normal
pH Level	7.51	normal	6.98	below normal	7.41	normal	7.85	normal	7.7	normal	7.92	normal	8.19	above normal
Water Level	1m	average	1m	average	1m	average	1m	average	1m	average	1m	average	1m	average

APPENDIX F

SPECIFICATION SHEETS

POND MONITORING SYSTEM COMPONENTS

1. ARDUINO UNO R3

SPECIFICATIONS	
Board Size	74.9×53.3mm
Microcontroller/Clock Speed	ATmega328P/16MHz
SRAM (Main Memory)	2kB
Flash Memory	32kB
EEPROM	1kB
Operating Voltage	+5V
Input Voltage (recommended)	+7～+12V
Output Voltage	+5V, +3.3V
Digital I/O Pins	20
PWM Digital I/O Pins	6
Analog Input Pins	6
Rated Current per Pin	40mA/Pin
Program Writing Pins	USB Type-B ICSP
Interface	UART I2C SPI

2. DS18B20 TEMPERATURE SENSOR

SPECIFICATIONS

- Programmable Digital Temperature Sensor.
- Communicates using 1-Wire method.
- Output Resolution: 9-bit to 12-bit (programmable).
- Unique 64-bit address enables multiplexing.
- Programmable alarm options.
- Available as To-92, SOP and even as a waterproof sensor.

Operating voltage	3V to 5V
Temperature Range	-55°C to +125°C
Accuracy	±0.5°C
Conversion time	750ms at 12-bit

PIN CONFIGURATION

PIN NUMBER	PIN NAME	DESCRIPTION
1	Ground	Connect to the ground of the circuit.
2	VCC	Powers the Sensor, can be 3.3V or 5V.
3	Data	This pin gives output the temperature value which can be read using 1-wire method.

3. ARDUINO PH SENSOR / METER KIT

SPECIFICATIONS	
• pH Sensor with BNC Connector • PH2.0 Interface (3-foot patch) • Gain Adjustment Potentiometer • Power Indicator LED	
Module Power	5.00V
Circuit Board Size	43mm×32mm
pH Measuring Range	0-14
Measuring Temperature	0-60 ˚C
Accuracy	± 0.1pH (25 ˚C)
Response Time	≤ 1min

4. HC-SR04 ULTRASONIC SENSOR (WATER LEVEL)

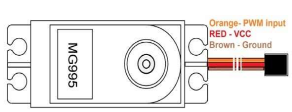
SPECIFICATIONS		
Operating voltage	+5V	
Theoretical Measuring Distance	2cm to 450cm	
Practical Measuring Distance	2cm to 80cm	
Accuracy	3mm	
Measuring angle covered	<15°	
Operating Current	<15mA	
Operating Frequency	40Hz	
PIN CONFIGURATION		
PIN NUMBER	PIN NAME	DESCRIPTION
1	VCC	The VCC pin powers the sensor, typically with +5V.
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

AUTOMATIC FEEDER COMPONENTS

1. ARDUINO MEGA 2560

SPECIFICATIONS	
Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA+
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

2. MG995 SERVOMOTOR



SPECIFICATIONS	
• Metal geared servo for more life • Stable and shock proof double ball bearing design • High speed rotation for quick response • Fast control response • Constant torque throughout the servo travel range • Excellent holding power	
Weight	55 g
Dimension	40.7×19.7×42.9mm
Operating voltage range	4.8 V to 7.2 V
Stall torque	9.4kg/cm (4.8v); 11kg/cm (6v)
Operating speed	0.2 s/60° (4.8 V), 0.16 s/60° (6 V)
Rotational degree	180°
Dead band width	5 µs
Operating temperature range	0°C to +55°C
Current draw at idle	10mA
No load operating current draw	170mA
Current at maximum load	1200Ma

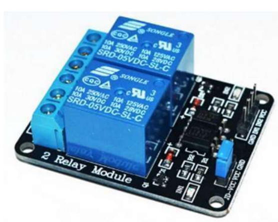
PIN CONFIGURATION

PIN NUMBER	PIN NAME	DESCRIPTION
1	Signal pin (Orange pin)	The PWM signal which states the axis position is given through this pin.
2	VCC (Red pin)	Positive power supply for servo motor is given to this pin.
3	Ground (Brown pin)	This pin is connected to ground of circuit or power supply.

3. LOAD CELL WITH HX711 MODULE

LOAD CELL SPECIFICATIONS	
• Parallel Beam Type • IP65 Rating • 47mm x 12mm x 6mm, 110mm Wire	
Capacity	100 g
Material	Aluminum-Alloy
HX711 MODULE SPECIFICATIONS	
Differential input voltage	±40mV (Full-scale differential input voltage is ± 40mV)
Data accuracy	24 bit (24 bit A / D converter chip.)
Refresh frequency	10/80 Hz
Operating Voltage	2.7V to 5VDC
Operating current	<10 mA

4. RELAY MODULE



SPECIFICATIONS	
Supply voltage	+5V
Supply current	144mA typ. (150mA max.)
Current on pin IN	14mA typ.
Rated load	7A 250VAC
Operating temperature	-30°C / +70°C
Operate time max.	10ms Max
Release time max.	5ms Max.
Insulation resistance	100Mohm Min.
Mechanical Life Expectancy	10,000,000 operations
Electrical Life Expectancy	10,000 operations
Dimensions	1.7” x 1.3” (43.2 x 33.0 mm)
Weight	0.92oz (26.2g)

5. DC MOTOR

SPECIFICATIONS	
Supply voltage	+5V
Revolutions per minute	1,000 rpm
No-load current	About 25mA
Size	Approx. 24.5 x 12.5mm (Dia. x H)
Color	Silver

APPENDIX G

STATISTICAL ANALYSIS

The study will use inferential statistics that will make the prediction and will test the hypothesis of the data being produced. The study shall be using the t-test analysis in which the control group will be the standard computed value of the amount of feed while the experimental group will be the feed generated by the feeding system produced in this study. The results in this test will be derived with 0.05 as the significance level or risk level which is called the alpha (α).

$$\boldsymbol{t} = \frac{\bar{\boldsymbol{x}}_1 - \bar{\boldsymbol{x}}_2}{\sqrt{\frac{\boldsymbol{S}^2}{\boldsymbol{n}_1} + \frac{\boldsymbol{S}^2}{\boldsymbol{n}_2}}} \quad \textbf{(2)}$$

Equation 2. Two sample T-test

Where:

t = t-value

$\bar{\boldsymbol{x}}_1$ and $\bar{\boldsymbol{x}}_2$ = Means of the two groups

S² = common variance of the two samples

$\mathbf{n_1}$ and $\mathbf{n_2}$ = total number of samples

The common variance (S^2) of the two samples can be calculated as:

$$S^2 = \frac{\sum(\mathrm{x} - \bar{\boldsymbol{x}}_1)^2 + \sum(\mathrm{x} - \bar{\boldsymbol{x}}_2)^2}{\mathrm{n}_1 + \mathrm{n}_2 - 2} \quad \textbf{(3)}$$

Equation 3. Common Variance for Two sample T-test

In this test, we will also need to identify the degrees of freedom (df) to determine the p-value which is calculated as:

$$\mathrm{df} = \mathrm{n}_1 + \mathrm{n}_2 - 2 \qquad \textbf{(4)}$$

Equation 4. Degrees of Freedom for Two sample T-test

The value for the level of significance (p-value) corresponds to the alpha indicated in the t-distribution table (Table 4) for the calculated absolute t-value. When the p-value will be greater than the alpha set (0.05) then the null hypothesis will be not rejected otherwise it will be rejected. For this study, the null hypothesis is $\overline{x_1} = \overline{x_2}$ or the difference between the two means is zero, meaning there is no significant difference between the means of these two sets. The values in the top most row are the values for t distribution probabilities (alpha) and the values in the left most part of the table corresponds to the degrees of freedom (df).

Table 5. T-distribution Table

Df/α	0.9	0.5	0.3	0.2	0.1	0.05	0.02	0.01	0.001
1	0.158	1	2	3.078	6.314	12.706	31.821	64	637
2	0.142	0.816	1.386	1.886	2.92	4.303	6.965	10	31.598
3	0.137	0.765	1.25	1.638	2.353	3.182	4.541	5.841	12.929
4	0.134	0.741	1.19	1.533	2.132	2.776	3.747	4.604	8.61
5	0.132	0.727	1.156	1.476	2.015	2.571	3.365	4.032	6.869
6	0.131	0.718	1.134	1.44	1.943	2.447	3.143	3.707	5.959
7	0.13	0.711	1.119	1.415	1.895	2.365	2.998	3.499	5.408
8	0.13	0.706	1.108	1.397	1.86	2.306	2.896	3.355	5.041
9	0.129	0.703	1.1	1.383	1.833	2.263	2.821	3.25	4.781
10	0.129	0.7	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	0.129	0.697	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12	0.128	0.695	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	0.128	0.694	1.079	1.35	1.771	2.16	2.65	3.012	4.221
14	0.128	0.692	1.076	1.345	1.761	2.145	2.624	2.977	4.14
15	0.128	0.691	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	0.128	0.69	1.071	1.337	1.746	2.12	2.583	2.921	4.015
17	0.128	0.689	1.069	1.333	1.74	2.11	2.567	2.898	3.965
18	0.127	0.688	1.067	1.33	1.734	2.101	2.552	2.878	3.922
19	0.127	688	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	0.127	0.687	1.064	1.325	1.725	2.086	2.528	2.845	3.85
21	0.127	0.686	1.063	1.323	1.721	2.08	2.518	2.831	3.819
22	0.127	0.686	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	0.127	0.685	1.06	1.319	1.714	2.069	2.5	2.807	3.767
24	0.127	0.685	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	0.127	0.684	1.058	1.316	1.708	2.06	2.485	2.787	3.725
26	0.127	0.684	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27	0.137	0.684	1.057	1.314	1.703	2.052	2.473	2.771	3.69
28	0.127	0.683	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	0.127	0.683	1.055	1.311	1.699	2.045	2.462	2.756	3.649
30	0.127	0.683	1.055	1.31	1.697	2.042	2.457	2.75	3.656
40	0.126	0.681	1.05	1.303	1.684	2.021	2.423	2.704	3.551
80	0.126	0.679	1.046	1.296	1.671	2	2.39	2.66	3.46
120	0.126	0.677	1.041	1.289	1.658	1.98	2.358	2.617	3.373
Infini	0.126	0.674	1.036	1.282	1.645	1.96	2.326	2.576	3.291

Hypotheses

The following are the hypotheses for a two-sample t-test:

H_o: The shrimp weight after 70 days of cultivation using manual feeding and using the feeding device are equal; $\overline{x_1} = \overline{x_2}$. Therefore, there is no significant difference between the feed amount generated using manual feeding and the feed amount generated by the feeding system.

H_1: The shrimp weight after 70 days of cultivation using manual feeding and using the feeding device are not equal; $\overline{x_1} \neq \overline{x_2}$. There is a significant difference between the feed amount generated using manual feeding and the feed amount generated by the feeding system.

Calculations

Where:

$\mathbf{T_{FS}}$ = Total Feed Standard

$\mathbf{T_{FE}}$ = Total Feed Experimental

t = t-value

$\mathbf{n_1}$ and $\mathbf{n_2}$ = Total Number of Samples

$\mathbf{s_1^2}$ and $\mathbf{s_2^2}$ = Variance of Two Samples

Standard/Exact Feed of Feeding	Experimental Feed of Feeding System
$\mathbf{T_{FS}}$ = 3639.88g	$\mathbf{T_{FE}}$ = 3623.14g
$\boldsymbol{x_1}$ = 72.7976g	$\boldsymbol{x_2}$ = 72.4628g
$\mathbf{n_1}$ = 50	$\mathbf{n_2}$ = 50
$\mathbf{s_1^2}$ = 385.9244	$\mathbf{s_2^2}$ = 314.9739
t = 0.089	t = 0.089

For Equation 3:

Variance of Two Samples

$$s_1^2 = \frac{\sum X1^2}{n_1} - \overline{\boldsymbol{x}}_{\boldsymbol{1}}^{\,2} \qquad s_2^2 = \frac{\sum X2^2}{n_1} - \overline{\boldsymbol{x}}_{\boldsymbol{2}}^{\,2}$$

$$s_1^2 = \frac{284270.748}{50} - 72.7976^2 \qquad s_2^2 = \frac{278291.5638}{50} - 72.4628^2$$

$$s_1^2 = \mathbf{385.9244} \qquad s_2^2 = \mathbf{314.9739}$$

For Equation 2:

T-value

$$t = \frac{\overline{\boldsymbol{x}}_{\boldsymbol{1}} - \overline{\boldsymbol{x}}_{\boldsymbol{2}}}{\sqrt{\frac{s^2}{n_1} + \frac{s^2}{n_2}}}$$

$$t = \frac{72.7976 - 72.4628}{\sqrt{\frac{385.9244}{50} + \frac{314.9739}{50}}}$$

$$t = \frac{0.3348}{\sqrt{14.01}}$$

$$t = \mathbf{0.089}$$

For Equation 4:

Decrees of Freedom

$$dF = n_1 + n_2 - 2$$

$$dF = 50 + 50 - 2$$

$$dF = \mathbf{98}$$

Significance Level

$$\alpha = \mathbf{0.05\ (5\%)}$$

$$table_t = \mathbf{1.6608}$$

Standard Error of Difference between Two Means

$$S\,\bar{x}_1 - \bar{x}_2 = \sqrt{\left(\frac{n_1 - s_1 2 + s_2 2}{n_1 + n_2 - 2}\right)\left(\frac{n_1 + n_2}{n_1 n_2}\right)}$$

$$S\,\bar{x}_1 - \bar{x}_2 = \sqrt{\left(\frac{50(385.9294) + 50\,(314.9739)}{50 + 50 - 2}\right)\left(\frac{50 + 50}{50(50)}\right)}$$

$$S\,\bar{x}_1 - \bar{x}_2 = \sqrt{14.3040}$$

$$S\,\bar{x}_1 - \bar{x}_2 = \mathbf{3.7820}$$

Therefore, we conclude that the total accuracy of feeding device is **96.21%**.

APPENDIX H

PRODUCTION COST SUMMARY

The table shows below is the overview of production cost of the research. All the cost of each component is dependent on the receipt from various electronic shops and electronic online shops. These components were selected for its compatibility to our specifications and/or requirements. The researchers examine each specification before buying the components to ensure its quality.

Table 6: The Production Summary of the Study

Materials	Amount	Quantity	Equivalent
Weighing load cell sensor 10kg	₱489	1pc	₱489
Weighing load cell sensor 5kg	₱489	1pc	₱489
Weighing load cell sensor 100g	₱222	1pc	₱222
Digital weighing scale 100g	₱399	1pc	₱399
HX711 module	₱75	2pcs	₱150
AC motor	₱379	1pc	₱379
Acrylic sheet	₱420	1pc	₱420
Acrylic sheet (1.6m 24” x 36”)	₱480	1pc	₱480
Plier	₱59	1pc	₱59
Steel tape	₱49	1pc	₱49
Screwdriver set	₱79	1set	₱79
Grinder disc	₱20	1pc	₱20
Rubber stand	₱3.75	4pcs	₱15
Bolts and nuts	₱3	100pairs	₱300
Sandpaper	₱20	1pc	₱20
Grinder disc	₱58	1pc	₱58
Screw # $^{1/8}$	₱28	2pcs	₱56
Battery	₱15	1pc	₱15
Tape	₱12	1pc	₱12
DC motor	₱195	1pc	₱195
Acrylic sheet	₱300	1pc	₱300
Drill disc	₱36.25	4pcs	₱145
Grinder	₱850	1pc	₱850
Spray paint	₱150	3pcs	₱450
Masking tape	₱20	2pcs	₱40
Socket	₱50	1pc	₱50
Receptacle	₱80	1pc	₱80
MCU motor	₱285	1pc	₱285
Brushless motor	₱341	1pc	₱341
Steel bond	₱120	1pc	₱120
Acrylic sheet	₱200	1pc	₱200
Ord. wire	₱60	1mtr	₱60
Bolt set	₱16	4set	₱64
Grinder disc	₱32	4pcs	₱128
Welding rod	₱135	2sets	₱270
G.I Pipe #1 ½	₱1,210	1pc	₱1210
Bolt x30 stainless	₱30	3pcs	₱90
Nut stainless	₱10	1pc	₱10
Nut ord.	₱6	2pcs	₱12
Nut x23	₱23	2pcs	₱46
Stranded wire	₱3	140mtrs	₱420
Steel fabrication	₱3000	1pc	₱3000
Sprinkler	₱1000	1pc	₱1000

Strainer	₱400	1pc	₱400
Ord. Plywood $^{1/2}$	₱520	2sheets	₱1040
Trapal 12 ft.	₱85	2mtrs	₱170
Concrete nails #4	₱20	1/4kg	₱20
Bullet terminal	₱8	8pcs	₱64
Hard nail	₱30	1/4kg	₱30
Coco lumber 2x2x12	₱76	2pcs	₱152
Shrimp feeds	₱100	1kg	₱100
Bolts	₱28	1set	₱28
Manpower labor	₱2250	1	₱2250
Gasoline	₱800	1	₱800
Total	₱17,153		

APPENDIX I

PROJECT CYCLE PLAN

ACTIVITIES	2020											
	AUGUST				SEPTEMBER				OCTOBER			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Orientation and Planning for the Project												
Canvassing and Procurement of Components and Materials												
Device Construction and Programming												
Function Testing												
Calibration and Troubleshooting												
Final Checking of the Project												
Conceptualizing and Planning of Thesis Papers												
Research of References for RRL about Automated Feeder												
Creation of Final Paper												
Revision of Final Paper												
Device and Papers Final Defense												

ACTIVITIES	2020								2021			
	NOVEMBER				DECEMBER				JANUARY			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Orientation and Planning for the Project												
Canvassing and Procurement of Components and Materials												
Device Construction and Programming												
Function Testing												
Calibration and Troubleshooting												
Final Checking of the Project												
Conceptualizing and Planning of Thesis Papers												
Research of References for RRL about Automated Feeder												
Creation of Final Paper												
Revision of Final Paper												
Device and Papers Final Defense												

ACTIVITIES	2021											
	FEBRUARY				MARCH				APRIL			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Orientation and Planning for the Project												
Canvassing and Procurement of Components and Materials												
Device Construction and Programming												
Function Testing												
Calibration and Troubleshooting												
Final Checking of the Project												
Conceptualizing and Planning of Thesis Papers												
Research of References for RRL about Automated Feeder												
Creation of Final Paper												
Revision of Final Paper												
Device and Papers Final Defense												

ACTIVITIES	2021											
	MAY				JUNE				JULY			
	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4	Week 1	Week 2	Week 3	Week 4
Orientation and Planning for the Project												
Canvassing and Procurement of Components and Materials												
Device Construction and Programming												
Function Testing												
Calibration and Troubleshooting												
Final Checking of the Project												
Conceptualizing and Planning of Thesis Papers												
Research of References for RRL about Automated Feeder												
Creation of Final Paper												
Revision of Final Paper												
Device and Papers Final Defense												

APPENDIX J

The University of Mindanao

RESEARCH AND PUBLICATION CENTER

[✓] Main [ ] Branch ______________

ASSIGNMENT OF RESEARCH PERSONNEL

Course Code: 6525

Program: BS-CPE

This is to acknowledge acceptance of assignment as Research Personnel for the thesis entitled:

Microcontroller-driven Feeding Management and Automation for L.vannamei Shrimp Aquaculture.

	Name	Signature	Date
Adviser	Engr. Krisca Lynge C. Donayre		January 08, 2020
Statistician/Data Analyst	Engr. Hanna Leah P. Angelia		January 08, 2020
Editor	Engr. Krisca Lynge C. Donayre		January 08, 2020
Panel Members	Engr. Randy E. Angelia		January 08, 2020
	Engr. Jetron J. Adtoon		January 08, 2020

Endorsed by: Engr. Jetron J. Adtoon
Research Coordinator/Asst. Research Coordinator

Approved by: Engr. Carlito Cañesares
Dean of College

F-13100-019 /Rev. # 0 /Effectivity: January 25, 2018

APPENDIX K

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The University of Mindanao

ENDORSEMENT FOR FINAL DEFENSE

Date:

This is to endorse the research manuscript, entitled: "**Microcontroller-driven Feeding Management and Automation for L. vannamei Shrimp Aquaculture**" prepared and submitted by **Glory Mae M. Flores, Elmer John C. Fernandez,** and **Jerah Mae B. Ferrer** for Final Defense. The manuscript has been evaluated by the research personnel listed below and was found to be compliant with the quality standards as provided in the UM Research Manual.

	Name of Personnel	Signature
Adviser	Engr. Krisca Lynge C. Donayre	
Statistician	Engr. Hanna Leah P. Angelia	

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Dean, College of Engineering Education

APPENDIX L

Grammarly Report

grammarly

Report: Paperonly-6.5rev

Paperonly-6.5rev

by Delan Bacus

General metrics

28,308	4,417	423	17 min 40 sec	33 min 58 sec
characters	words	sentences	reading time	speaking time

Score

98

This text scores better than 98% of all texts checked by Grammarly

Writing Issues

64	21	43
Issues left	Critical	Advanced

Plagiarism

This text hasn't been checked for plagiarism

Approved by:

Engr. Krisca Lynge C. Donayre
Adviser

Engr. Delan Bacus
Grammarly Statistician

APPENDIX M

Certificate of Plagiarism Check and Turnit in Report

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Type of paper:

- [x] Bachelor's thesis/capstone
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Name of author/s:

Glory Mae M. Flores, Elmer John C. Fernandez, Jerah Mae B. Ferrer

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Date : March 10, 2022

Title : **Microcontroller-driven Feeding Management and Automation for L.vannamei Shrimp Aquaculture**

Student-Proponents	Program
1. Glory Mae M. Flores	BSCPE
2. Elmer John C. Fernandez	BSCPE
3. Jerah Mae B. Ferrer	BSCPE

Panel Comments/ Recommendations	Previous Status	Actions Taken / Revisions	Page Reflected
The abstract must be at least 150 words instead of 250.	250 words for abstract	150 words	Page 1
The total accuracy must be in 2 decimal places.	96.218%	96.21%	Page 1
Fig. 5 change to block diagram instead of flowchart.	Flowchart	Block Diagram	Page 3
Fig. 8 remove the highlighted words from the block diagram.	Highlighted Fig. 8 Block diagram words	Unhighlighted Fig. 7 Block Diagram words	Page 4
Fig. 9 must provide a better output of the design.	An untidy look of actual design image	The image changed to better output	Page 4
Must put the data results of pH level, water level, and water temperature.	No data results	Fig 9. The graph of pond monitoring system result,	Page 5
Formula Equations must be seen only in appendices.	Formulas are shown in the paper	Formulas are in appendices	Page 5

**You may use additional pages as necessary*

APPROVALS:

C Complied NC Not Complied	Thesis Adviser / Editor	Signature	Date
C	Engr. Krisca Lynge C. Donayre		March 12, 2022

C Complied NC Not Complied	Statistician	Signature	Date
	Engr. Hanna Leah P. Angelia		March 22, 2022

C Complied NC Not Complied	Panel Members	Signature	Date
C	Engr. Randy E. Angelia		March 14, 2022
C	Engr. Jetron J. Adtoon		March 15, 2022

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C	Engr. Jetron J. Adtoon		March 15, 2022

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AUTHORIZATION LETTER

This is to authorize the University of Mindanao and adviser/co-author, **ENGR. KRISCA LYNGE C. DONAYRE,** of the study entitled **MICROCONTROLLER-DRIVEN FEEDING MANAGEMENT AND AUTOMATION FOR L. VANNAMEI SHRIMP AQUACULTURE** to present the paper in local, national or international research conferences; publish the paper in local, national or international research journals; and/or submit the paper for national or international intellectual property protection. It is therefore the responsibility of the adviser to ensure that the primary authors/inventors/makers/designers are given due recognition.

The Researchers

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- **Python Programming Seminar and Workshop**
  February 01, 2020
  University of Mindanao
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- **Introduction to DevOps: The Game Changer of Cloud Computing**
  October 17, 2020
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- **Software Quality Assurance and Its Role in Industry**
  October 19, 2020

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- **Vue.js Framework Webinar**
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- **Introduction to DevOps: The Game Changer of Cloud Computing**
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  16-Hour Continuing Professional Education Program (CPEP)
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  4-Hour Financial Literacy and Management Program (FLMP)

  June 12, 2018
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- **Information Security Through Access Control**
  August 3, 2019
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- **ITIL Process**

August 24, 2019
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- **Computer Networks**
  August 31, 2019
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- **Google Machine Learning API’s**
  September 7, 2019
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- **Human-Centered Design and Engineering:**
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  September 10, 2020
  Philippines Webinar Series No.3

- **Integrating Social Sciences and Humanities in Engineering**
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Proponents: Glory Mae M. Flores — Program: BS - CPE

Elmer John C. Fernandez — Course Code: 6525

Jerah Mae B. Ferrer — Semester/SY: 2021- 2022

Name	Date Received	Signature	Date Released	Signature	Remarks
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Statistician Engr. Hanna Leah P. Angelia	January 08, 2020		March 15, 2022		
Panel 1 Engr. Randy E. Angelia	January 08, 2020		March 15, 2022		
Panel 2					
Panel 3 (RC/ARC) Engr. Jetron J. Adtoon	January 08, 2020		March 15, 2022		
Plagiarism Check	March 08, 2022		March 15, 2022		
Editor Engr. Krisca Lynge C. Donayre	March 08, 2022		March 15, 2022		
Dean Dr. Charlito L. Cañesares	March 16, 2022		March 16, 2022		

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