POLYTECHNIC UNIVERSITY OF THE PHILIPPINES

AN AUTOMATED GREEN MUSSEL CLEANER FOR THE MUSSEL FARMERS AND VENDORS IN PARAÑAQUE CITY

A Design Project Proposal
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Chapter 1

THE PROBLEM AND ITS SETTING

Introduction

Aquaculture is one sector of the Philippine industry that directly contributes to the country's food security, employment, and economy. The Food and Agriculture Organization of the United Nations (FAO, 2022) has identified the seven major aquaculture species in the Philippines: the green mussel. To further promote the growth and survival of green mussels for commercial production, the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (DOST-PCAARRD) promoted the longline and raft methods in farming mussels since it has shown better mussel growth and survival rate.

The National Oceanic and Atmospheric Administration (2021) said that ocean acidification (OA) has a big impact on shellfish. The absorption of the increased level of carbon dioxide in the atmosphere results in the decrease of the ocean's pH level, making it acidic. The effects of OA hinder calcification in shell builders like oysters, mussels, and corals.

Considering that cultured green mussels are of commercial value, the mussels should be cleaned before being marketed. Shellfish cleaning machines were designed to help in easing human labor by cleaning the exterior of shells.

With this, the need arises for a machine that can clean mussels accurately and efficiently.

It was said that mussel physiology is greatly affected by lower pH, making it more susceptible to death, thinner shells, and weaker byssal attachment (Gazeau et al, 2010; Fitzer et al, 2015; Pfister et al, 2016, as cited in Law et al, 2020)

As said by (Fitzer et al, 2015), ocean acidification greatly reduced the aragonite/calcite ratio of the shells, denoting that there's a decrease in the thickness of the mussel shells.

Dong et al. (2016) mentioned that many shellfish processing technology and equipment has not been widely promoted due to their cost, performance, and other reasons. In addition, they have stated that even if the production and export volume of shellfish is large, processing areas stop at pretreatment, making automatic shellfish cleaning devices scarce.

According to Basharie et al. (2021), shellfish cleaning machines are developed to facilitate the cleaning of shellfish with rough surfaces such as cockles and oysters. However, these machines are almost non-existent in the Malaysian market.

The report of Tandale, Shivpuje, and Ladkat (2015) focused on making a portable washing machine that efficiently cleans small components. They have stated that each cleaning problem is unique from one another since many variables affect the manufacturing process.

The studies mentioned above only discussed the effects of ocean acidification on the shells of bivalves and did not include the process of cleaning mussels with decreased shell thickness; focused on a shellfish cleaner that is not automated and can only be used manually; and lastly, only developed a machine that was only focused on ridding components of grease, wax, flux, scale, chips, fines, shop dirt, oil contaminants and not on cleaning shellfish of algae or barnacles.

Objectives of the Study

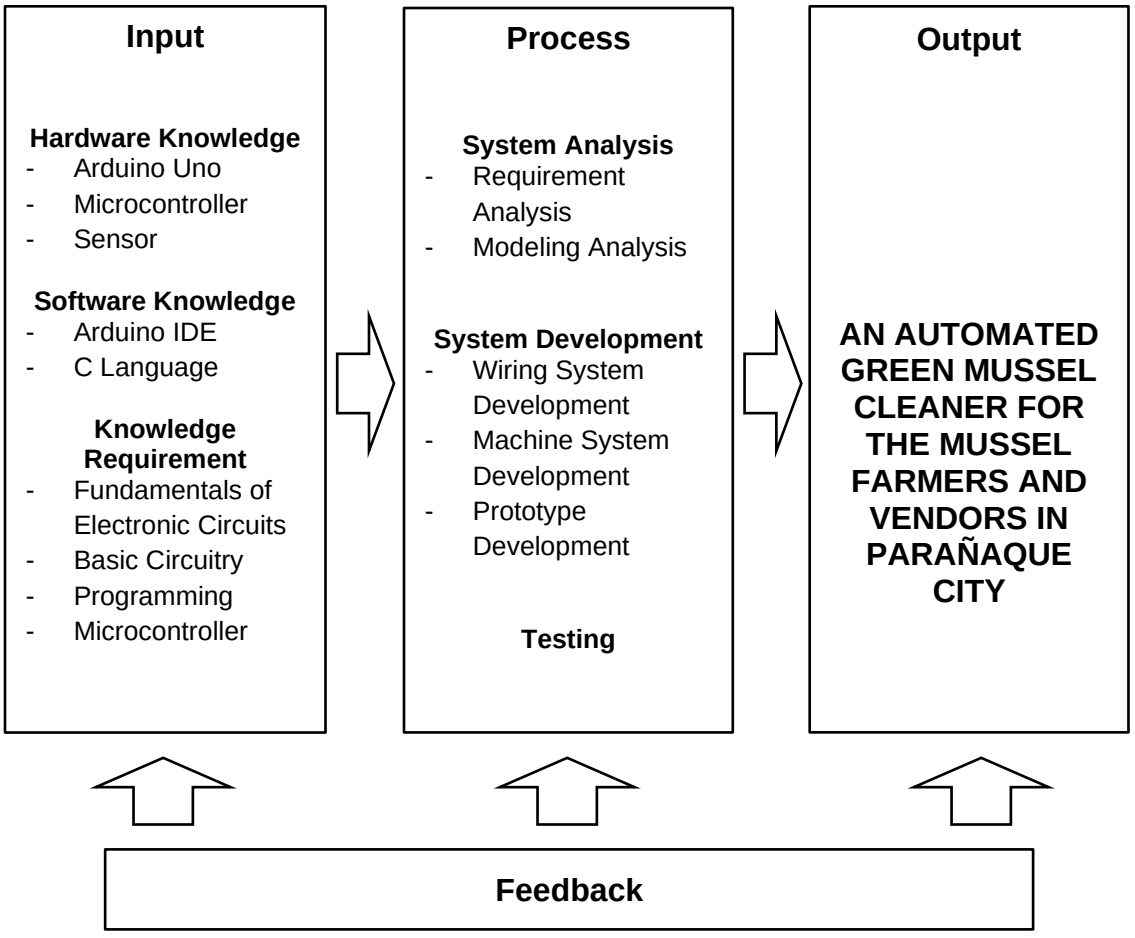
The purpose of this study is to further develop the machine made by previous researchers, minimize the manual labor of cleaning cultured green mussels, and make a low-cost machine that can be used by mussel farmers and vendors.

The researchers also aim to maintain the good quality and marketability of cultured green mussels by making a machine that will clean the mussels without damaging their exterior.

Conceptual Framework

The conceptual framework was built on the theory and concept provided. The paradigm below shows the outline of the study and how the technology for the research is related to one another.

Figure 1. Conceptual Framework Paradigm



Theoretical Framework

In Abraham Maslow's Hierarchy of Needs, the lowest needs to be met are the physiological needs. This refers to basic physical needs of people like water, food, shelter, etc. Maslow has considered physiological needs as the most important out of all our needs.

The Philippine Green Mussel, locally known as tahong, is an abundant food source in the country. Tahong is easily cultured due to its fast growth rate and sturdy nature. Success in its farming can be contributed to the bodies of water surrounding the Philippines.

The meat of the Philippine green mussel, however, is the main reason for its popularity among communities. They are a cheap source of protein and the variations in the way of its cooking help maintain its popularity among consumers.

The cleaning of these abundant food source is important since it is a physiological need that multiple families are relying on.

Statement of the Problem

This study aims to apply the conceptual knowledge of several computer engineering principles and technologies to develop the Automated Green Mussel Cleaner for Mussel Farmers and Vendors in Parañaque City. Specifically, the researchers would like to answer the following questions:

1. What are the stages to undertake in the development of the system and the device for the proposed project entitled “An Automated Green Mussel Cleaner for Mussel Farmers and Vendors in Parañaque City”?

2. What is the evaluation of the users regarding the proposed system and device based on the product quality characteristics of the ISO 25010 also known as “Systems and Software Engineering-Systems and Software Quality Requirements and Evaluation-System and Software Quality Models” in terms of:
   2.1. Functionality;
   2.2. Reliability;
   2.3. Usability;
   2.4. Security; and,
   2.5. Maintainability?

3. Is there a statistically significant difference in the evaluations of the users regarding the proposed project when they are grouped according to their profiles?

4. How effective is the proposed system and device in terms of the following parameters:
   4.1. Accuracy;
   4.2. Cleaning; and,
   4.3. Speed?

5. What are the issues and challenges encountered by the users in using the proposed system and device?

6. What training programs can be implemented based on the results and findings of this study?

Hypothesis

H_0- There is no significant difference between the evaluations of the participants regarding the proposed system and device based on the product quality characteristics of the ISO 25010 also known as “Systems and Software Engineering-Systems and Software Quality Requirements and Evaluation-System and Software Quality Models” when they are grouped according to their profiles.

H_0- The system is not effective in terms of accuracy, cleaning, and speed.

H_1- There is a significant difference between the evaluations of the participants regarding the proposed system and device based on the product quality characteristics of the ISO 25010 also known as “Systems and Software Engineering-Systems and Software Quality Requirements and Evaluation-System and Software Quality Models” when they are grouped according to their profiles.

H_1- The system is effective in terms of accuracy, cleaning, and speed.

Scope and Limitations of the Study

The study intends to further improve the automatic washing machine for mussels, made by previous students. The development of the said device will help in easing the manual labor of mussel farmers and vendors in cleaning up the green mussels.

The proponents seek to help the mussel farmers and vendors in Parañaque City by developing a better automated green mussel cleaner. However, this study is only limited to cleaning green mussels from mussel farmers and vendors residing in Parañaque City.

The study will be conducted during the A.Y. 2022-2023.

Significance of the Study

The research will primarily benefit the mussel farmers and vendors in Parañaque and Bacoor City once the machine has been fully implemented in the future. The creation of the mussel cleaning machine will be beneficial for the following entities:

Mussel Farmers and Vendors. The study will benefit the mussel farmers and vendors in Parañaque and Bacoor by allowing them to easily clean and retrieve the mussels without any damage.

Philippine Fisheries Development Authority (PFDA). The development of the device in this study can help the corporation in improving the handling and distribution of mussels. The device can also be used and adapted in the future.

Local Government of Parañaque and Bacoor. The findings of this study can serve as a reference that the government can use. To further develop the machine, aid in reducing manual labor, and make a cheaper machine for the use of mussel farmers and vendors.

Proponents. The study will help the proponents in being more knowledgeable about the subject and concepts that will be used in the study.

Future Researchers. The findings of this study could be used as a reference for further enhancements to the machine or future studies regarding automatic bivalve cleaners.

Definition of Terms

This section discusses the technical terms used in this research. The following terminologies are conceptually and operationally defined for better understanding of the readers.

Aquaculture. Breeding, rearing, and harvesting of fish, shellfish, bivalves, and other aquatic organisms for food.

Cultured. A group of organisms that are grown or reproduced.

Microcontroller. A small and low-cost microcomputer designed to perform specific tasks of embedded systems.

Ocean Acidification. The reduction in the pH of the ocean over an extended period is primarily caused by excess carbon dioxide.

Philippine Green Mussel. A bivalve belonging to the family Mytilidae. It is harvested for food but is also known to harbor toxins and cause damage to submerged structures such as drainage pipes.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents the reviewed literatures and studies published in national and international journals. The discussion is presented using thematic approach.

This chapter will cover six (6) topics: the software development, hardware development, evaluation using the ISO 25010, effectiveness of the system, issues and challenges in using the system, and intervention / training programs.

Software Development

Before writing software for any purpose, an algorithm should be set out. The algorithm should include the configuration bits, direction of data flow across a port, and type and frequency of the external oscillator which acts as a timer for the microcontroller to schedule its activities (Tanshi & Bello, 2014).

Louis (2017) said that the Arduino microcontroller uses a software for developing codes called the Arduino Integrated Development Environment or simply known as Arduino IDE. The Arduino IDE is a simplified platform that can be

used on regular personal computers and allows users to write programs for Arduino using C or C++ language.

Embedded C is said to be an extension of the C programming language by Naik (2020). It is an extension that provides support when one is developing programs for embedded devices. However, though it may be an extension, it is not a part of the C language. Embedded C and C language use the same syntax and semantics, but embedded C has the additional I/O hardware addressing, fixed-point arithmetic operations, accessing address spaces, etc.

An induction motor is the most widely used motor for appliances, industrial control, and automation. To control the speed of an induction motor, the novel open loop phase control method must be used. This can be developed through a program using Arduino. By controlling the pulses from the Arduino, the speed of the induction motor can also be controlled (Kumar et al., 2013; as cited in the work of David et al., 2020).

In the study of Demetgul, Ulkir, and Waqar (2014), they used fuzzy logic in modeling the system of a washing machine. They have stated that in order to apply fuzzy logic to washing, establishing input and output parameters that act as fuzzy logic rules is necessary in achieving economical washing.

Hardware Development

According to Ojo et al. (2022), to develop a machine that gives optimal performance, there are some factors to consider during the design phase of the machine. Its capacity, material resistance to corrosion, ease of fabrication,

operation and maintenance, and use of food grade stainless steel are some of the factors to consider in creating an industrial-based vegetable leaf washing machine.

Schubert, D'Ausilio, and Canto (2013) mentioned that the Arduino is a name of a family of microcontroller boards. It can connect easily to a Windows PC, Mac, or Linux via USB. It is an open-source hardware which makes it accessible and modifiable to everyone that wishes to use it. Its software is also open-source and free. Due to this, Arduino has gained a large community that develop hardware and software that is compatible with the Arduino.

Adenowo et al. (2019) proposed an automatic washing machine that uses the 16F628A microcontroller which is designed and programmed to control various functions like the timings for washing, rinsing, and drying, alarm, supply of water, etc. The microcontroller is responsible for determining the level of water to be used, starting the motor, and control the water exit.

The eco-friendly washing machine of Sakidin et al. (2017) used materials that can be acquired easily. Some of these materials are a plastic bin with cover, rotary disk with ridges, and a hollow plastic foundation. They have stated that the rotary disk to be situated inside the washing machine is the most important part since it performs the cleaning. The rotation of the rotary disk also rotates the contents inside the washing machine. This enables the water with the cleaning agent to remove the dirt from clothes.

The conveyor belt was considered as a buffer against metal in the study of Oyeleke et al. (2014). The conveyor belt was said to reduce the velocity of the

fruits inside the chamber and minimize the chances of damages to it. In attention to this, they chose to use a conveyor belt made with balata belt.

Evaluation using the ISO 25010

Nyari & Kerti (2021), said that the ISO/IEC 25010 standard defines quality requirements of software development in eight areas (functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, portability). Seven of eight of the categories are related to non-functional requirement. This implies that the quality of software does not entirely depend on functional conformity.

In the study of Ramos (2021), IT experts and end-users were given different sets of questionnaires. The IT experts were given the complete set of the ISO 25010 Software Product Quality Standards which comprises of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability while end-users were only given questionnaires including the functional suitability, usability, and portability of the system. Inclusion of the other characteristics such as performance efficiency, compatibility, reliability, security, and maintainability to the questionnaires of end-users would be pointless since the characteristics could only be correctly assessed by IT experts.

The ISO/IEC 25010: 2011 Systems and software Quality Requirements and Evaluation or SQuaRE is divided into two quality models. Quality in Use and Product Quality are the quality models being referred to. Quality in Use is the

degree on which a product can be used by users to meet their needs, achieve specific goals and whatnot while Product Quality are characteristics that relate to properties of software and computer system (as cited in Estdale & Georgiadou, 2018)

Siavvas, Chatzidimitriou, and Symeonidis (2017) pointed out the main problem with ISO 25010. The ISO 25010 software quality standard has a good hierarchy of characteristics and sub-characteristics; however, it does not define how these characteristics and sub-characteristics are assessed and measured. To resolve this dilemma, researchers use the ISO 9126 and ISO 25010 as theoretical models then use their own interpretation on how each characteristic is measured.

The thesis of Foehr (2013) deals with quality under a technical perspective. The questions involved will answer on how it can be improved and ensured during engineering and production phases. Using the ISO 25010 would be unsuitable in the thesis since it is too focused on software systems in a hardware environment.

Effectiveness of the System

Basharie et al. (2021) made a manual cockle cleaning machine. The small machine was effective in ridding the cockles of dirt. Aside from cleaning cockles, the machine can also be used to clean other small shellfish alike.

The prototype of the new-type fruit vegetable washer of Dang et al. (2020) had a positive outcome. The washer performance was evaluated using different vegetables. After every experimental wash, it was evident that the vegetables used were visually free of foreign materials and undamaged.

R. N. Kenghe, Magar, & Kenghe (2015) concluded that the developed fruit washer machine's washing efficiency varied between 96.36% and 98.18%. Rotor C was recorded to have the highest efficiency with 98.18%, followed by rotor B with a recorded efficiency of 97.43%, and with rotor A having the lowest efficiency of 97.00%.

The automatic cleaning system for shellfish of Dong et al. (2016) designed an effective control system of cleaning for the machine. Their equipment has a higher automatization degree, better clean out quality, lower decay rate, stable and reliable capability, and easier operation and maintenance.

Zhao, Wu, Lu (2017) designed an automatic food cleaning machine based on SIMATIC LOGO. Using the SIMATIC LOGO! as its control core, combined with ultrasonic, ozone, and bubbles cleaning methods improves the washing and sterilization of food greatly. After carrying out the cleaning experiment, it was concluded that the prototype's performance is stable and reliable. It has a good cleaning effect and does not cause damage to the surface of the food.

Issues and Challenges in using the System

Q. H. Nguyen, Choi, & Nguyen (2014) stated that the vibrations of washing machines are issues to be considered. These vibrations are mainly caused by unbalanced load inside the washing drum. It is said to occur mostly during the spin-drying stage of the washing machine since the drum spins at high speed. This causes the load inside to press against the inner wall of the spin drum and relatively become a large, unbalanced mass.

The research article of Eiamsa-ard, Chantarajirawongb, and Thammakittipob (2021) compared their proposed machine to the RMUTL and ASL-XMJ10 machines. It was found that the proposed machine of the researchers consumed less water and has a shorter production time. However, when compared to the XMS40 machine, the proposed sesame seed washing machine requires more water and more time.

Multiple problems arise when using the traditional washing machine for olives, mentioned by Cappelli et al. (2019). Traditional washing machines have ineffective washing processes since contaminated water from the first batch get more contaminated as they get reused for the next batch of olives. It was also mentioned that the removal, cleaning, and filling of the water tank is a waste of time and consumes a lot of water. This entails that the traditional washing machines being used are inefficient and not effective for food production.

Yadav and Singh (2022) identified the three conveyor belt issues in material handling. These issues are carryback, mistracking, and slippage. These issues happen due to various reasons like substance sticking to the band, misaligned body, heavy load, frigidness, etc.

The study of Djekic, Tomic, and Milutinovic (2017) made a mathematical model to predict the beginning of delamination at rubber conveyor belts. Rubber conveyor belts may contain a steel core or multiple layers of rubber and canvas (carcass). The most common issues with using rubber conveyor belts with carcass is delamination. Delamination is defined as the separation of the rubber covers and carcass or the separation of the carcass plies at the edge of the belt.

Intervention / Training Programs

Kaur et al. (2015) indicated that most of the materials used in the portable DC washing machine have unacceptable social and environmental impacts. The mitigation of the effects is highly important as so as finding alternative materials that won't compromise the functionality of the machine. The portable washing machine may use a solar panel as an alternative and a service can be provided to users where dirty laundry will be washed, dried, and ironed weekly to answer some feasibility problems.

Training was said to be a key factor in affecting the choices of carp-farming practices in several Asian countries (Ahmed 1997; as cited in Kumar, Engle, & Tucker, 2018). Effective national and regional level trainings involving the coastal Indian farmers greatly improved aquaculture practices like pearl oyster farming, mud crab, and green mussel farming (Subramnannian 2013; as cited in Kumar, Engle, & Tucker 2018).

Ordonio et al. (2020) recommended future researchers in developing an extension program for the mussel farmers in Southern Negros Occidental. The mussel farmers had spoken on what should be improved upon regarding constraints in the development of the mussel farming industry. This drives future researchers to adopt a research-based development program focused on the analysis of the present status of mussel farming in southern Negros Occidental, recognition of socioeconomic benefits and incentives to benefit mussel farmers, recognition of the constraints and focus on sustainable mussel farming, and

development of a policy framework example, appropriate laws to protect mussel farming from unsustainable level and participate with the researchers in collecting information.

Cebu (2018) found out that about 2/3 of the participants in the study, which are green mussel farmers from Samar, have not attended any formal training related to green mussel production and post-harvest technologies. The participants attended mostly trainings involving mussel production (88.1%) and less on trainings involving post-processing technologies (11.9%).

The government of Gambia has developed a Gambian National Shellfish Sanitation Program (GNSSP) that strives to boost domestic consumer confidence in the sanitation of raw and freshly shucked shellfish from Gambian waters. To fully realize this program, the government of Gambia will develop a shellfish growing water certifications, sanitary handling procedures, and a cold chain from the harvest to the consumer (as cited in Rice et al., 2015)

Synthesis of the Reviewed Literature and Studies

The above-mentioned studies will aid in the development of an Automated Green Mussel Cleaner.

Information about the factors to consider in designing an industrial food washing machine will help the proponents in making a machine that give optimal performance (Ojo et al., 2022). The proponents may consider using fuzzy logic, 16F628A microcontroller, and balata conveyor belt from the studies of Demetgul

et al. (2014), Adenowo et al. (2019), and Oyeleke et al. (2014), in modeling the proposed green mussel cleaner to achieve economical washing and peak performance of the mussel cleaner.

Regarding the ISO 25010 standard, the study of Ramos (2021) may be employed. Giving IT experts and end-users different sets of questionnaires during testing of the machine will certainly ease the work of the researchers. Giving both participant groups the same questionnaires may impede the data gathering process and even result to untruthful data since end-users cannot correctly assess the characteristics of the ISO 25010 standard.

However, as said by Foehr (2013), the ISO 25010 standard is too focused on software. There may be difficulty in using the ISO 25010 in the proponent's proposed system since the green mussel cleaner is more focused on its hardware environment than in software.

There are multiple washing machines developed by researchers, each one yielding a positive outcome and were deemed effective in cleaning up the items being tested on. Previous thesis of researchers involving food cleaning machines like the works of Dang et al. (2020) and Dong et al. (2016), may serve as basis of the proponents for their own machine.

Like every machine, there will be issues in using them. Q.H. Nguyen, Choi, & Nguyen (2014) stated that vibrations of washing machines caused by unbalanced loads are issues to be considered. There are also inefficient and ineffective washing processes, and conveyor belt issues that need to be considered since they hinder production.

Once the green mussel washing machine is developed, the best method to employ and naturalize the machine into the work of mussel farmers and vendors, is for the researchers to collaborate with the government in developing training programs concerning the machine's proper use and maintenance. Formal trainings related to mussel cleaning technologies will boost the willingness of mussel farmers and vendors to adopt these technologies, easing manual labor and workload of the following entities, as recommended in the study of Ordonio et al. (2020).

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