OLIVAREZ COLLEGE TAGAYTAY

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SENIOR HIGH SCHOOL

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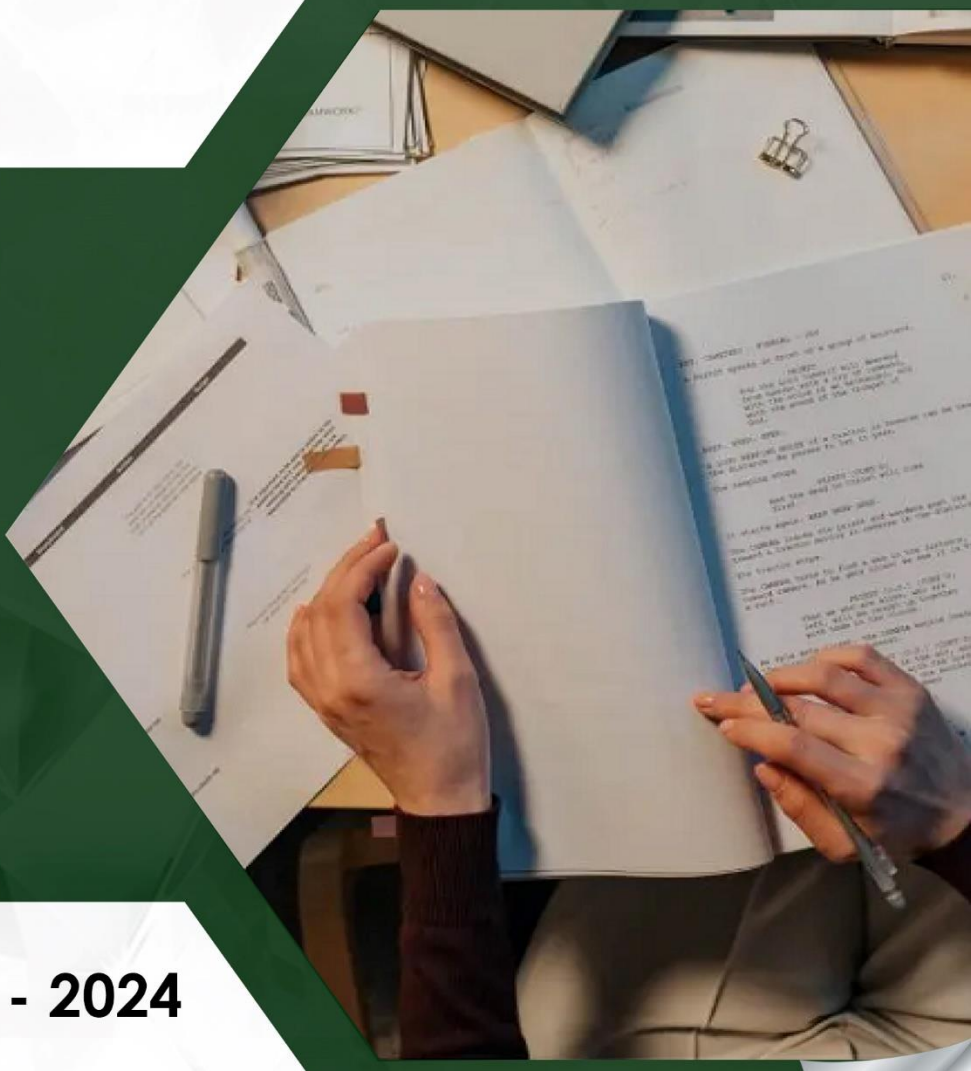

SCHOOL YEAR 2023 - 2024

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THE EDITORIAL BOARD

FOREWORD

The school year 2023-2024 has been a great year for the Senior High School academic community. Our students produced a remarkable collection of research. This volume represents not only the culmination of rigorous academic inquiry but also the beginning of a promising journey into the world of research and scholarship.

The array of topics covered in this year's Spectrum reflects the diverse interests and intellectual curiosity of the students. From groundbreaking science studies to innovative information technological explorations, each paper embodies the enthusiasm and commitment of young scholars who are eager to contribute to their fields of interest. These contributions are a testament to the students' dedication and the robust educational environment that has nurtured their growth.

For academicians, this collection offers a unique perspective on emerging research trends and the fresh viewpoints of a new generation of researchers. It serves as a window into the future of academic inquiry, showcasing how the next generation approaches complex problems and seeks creative solutions. The quality and depth of the work presented here underscore the potential that lies within these young minds and the importance of fostering their development through continued support and mentorship.

The support and guidance of our Senior High School Principal, Ms. Clarence A. Castillo, and our College Dean, Dr. Jean Rizza A. Dela Cruz, made the students' research endeavors more enriching and inspiring.

The following set of research students and their research advisers will have a high bar to reach as they indulge in their research work. This trend in research shows that Olivarez College Tagaytay is indeed a research-oriented institution. Stakeholders can all look forward to a more thought-provoking and exciting Senior High School journey with Research as its pinnacle.

MS. SHEILA V. OCAMPO, LPT

Research Coordinator

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Liquid Tree: An Innovative Approach for Improving Indoor Air Quality

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I. Abstract

The decline in indoor air quality is linked to the absence of trees in urban areas and continuous emissions of air pollutants. This study focuses on assessing the effectiveness of Chlorella Vulgaris Microalgae Paste in forming a functional liquid tree, while also examining its capacity to absorb carbon dioxide (CO2) through measuring Dissolved Oxygen (DO) levels and oxygen production. Employing a quasi-experimental methodology, the researchers utilized purposive sampling to select survey participants who met specific criteria: (1) professionals in the field of biology and chemistry, and (2) homeowners residing in Tagaytay City, Alfonso, and Silang. Guided by past research, researchers utilized Chlorella Vulgaris microalgae paste as the primary component of a liquid tree, supplemented by NPK nutrients, an air pump, and fluorescent light. The statistical treatment used was the weighted mean, with results interpreted as highly effective for each indicator. The researchers found that the liquid tree was highly acceptable in terms of size, odor, color, eco-friendliness, and longevity, and the Chlorella Vulgaris microalgae paste was also highly acceptable in terms of odor, color, and storage life. Based on the testing results from Santa Rosa Environmental Testing Laboratory, the liquid tree showed a presence of dissolved oxygen with 7.00 to 8.00 ppm. Despite the positive results, the researchers suggest finding out the amount of CO2 it can absorb and the exact amount of oxygen that the liquid tree can produce.

Keywords: *liquid tree, indoor air quality, Chlorella Vulgaris Microalgae Paste, dissolved oxygen, carbon dioxide, NPK nutrients*

II. Introduction

The decline in indoor air quality has been attributed to the lack of trees, especially in urban areas along with the continual release of air pollutants into the atmosphere. According to Grylls & Reeuwijk (2022), trees play a vital role in urban climates by effectively removing pollutants from the atmosphere, identified as potential solutions to two significant global urban challenges: poor air quality and the urban heat island effect. Inadequate tree coverage in urban areas also compromises indoor air quality by hindering the natural filtration of pollutants such as particulate matter and volatile organic compounds. Furthermore, the problem of increased atmospheric carbon dioxide content poses a significant risk to the current state of the environment. According to Politaeva et al. (2023) global temperatures rose precipitously as a result. In this sense, there has been a noticeable increase in the launch of Carbon Capture, Utilization, and Storage (CCUS) technologies in the past few years. In response to air pollution concerns, a study of Raeesossadati et al. (2014) states that one of the most promising bioremediation solutions now being investigated for various carbon dioxide (CO2) emission sources is microalgae. Microalgae may absorb CO2 from a variety of sources, including ambient CO2, industrial exhaust emissions, and soluble carbonates. Therefore, the researchers will use a viable Chlorella Vulgaris microalgae paste that will be mixed with distilled water. A Chlorella Vulgaris is a unicellular microalgae that can undergo photosynthesis. This microalgae will need powdered minerals such as nitrogen, phosphorus, and potassium to serve as their source of nutrients to reproduce properly. The mixture of Chlorella Vulgaris microalgae paste with the freshwater, together with the added nutrient solution can make a functional liquid tree that can lessen air pollution by absorbing CO2 and producing pure oxygen through photosynthesis.

In a previous study of Dhar et al. (2023), it indicates that Dr. Ivan Spasojevic developed the LIQUID3 containing freshwater microalgae that can capture CO2 and release oxygen. This novel creation is Serbia's first urban photo-bioreactor, a solution in the fight for clean air. It contains six hundred liters of water and works by using Chlamydomonas reinhardtii microalgae to bind carbon dioxide and produce pure oxygen through photosynthesis. Previous research on the liquid tree focused on providing an outside solution with multifunctional usage. On the other hand, this study intends on creating a liquid tree that will be suitable for an indoor environment. While the original liquid tree was larger and contained 600 liters of water, the researchers will downsize

it to 30 liters for space efficiency. Additionally, since the microalgae species used in the previous study was not readily available, this study will use another species of microalgae called Chlorella Vulgaris in a live paste form because of its availability in the market. The goal is to develop liquid tree technology that uses natural trees' air-purifying properties for indoor air pollution. This sustainable and environmentally friendly air purifier will collect contaminants and emit pure oxygen, thereby improving indoor air quality.

Consequently, a study conducted by the University of the Philippines Visayas College of Fisheries and Ocean Sciences (UPV-CFOS) developed a live microalgae paste for aquaculture hatcheries. According to Aya (2019), four commonly used microalgae species in aquaculture such as Tetraselmis sp., Nannochloropsis sp., Chaetoceros calcitrans, and Chlorella vulgaris are used to make microalgae paste. Moreover, the study indicates that the paste can be utilized as a starter to create a new batch of live microalgae besides being used as aquaculture feed. However, it should be noted that the aforementioned study only focuses on the live microalgae paste as an aquaculture feed. Therefore, the purpose of this quantitative research is to know if the Chlorella Vulgaris microalgae paste will be an effective component of a functional liquid tree. Additionally, this study aims to test the efficiency of the said microalgae species in terms of carbon dioxide absorption and oxygen production with the use of a dissolved oxygen meter. According to Abu Shmeis (2018), dissolved oxygen (DO) refers to the level of free, noncompound oxygen (O2) dissolved in water or other liquid. Oxygen enters water through diffusion from the surrounding air, through aeration, or as a byproduct of photosynthesis. The readings from the dissolved oxygen meter can be a great indicator that the microalgae are capable of carbon dioxide absorption and oxygen production. The results of this study could be of great help to those who live in urban areas where air pollution greatly affects the indoor environment.

This study aims to answer the following questions:

1. **How effective is the mixture of water, Chlorella Vulgaris microalgae paste, and NPK (nitrogen, phosphorus, and potassium) as the main component of liquid tree?**
2. **What are the characteristics that can be observed in the liquid tree in terms of:**
   2.1 Size
   2.2 Odor

2.3 Color

2.4 Eco-friendliness

2.5 Longevity

3. **What is the level of acceptability of Chlorella Vulgaris Microalgae Paste as the main component of the Liquid Tree in terms of:**

3.1 Odor

3.2 Color

3.3 Storage Life

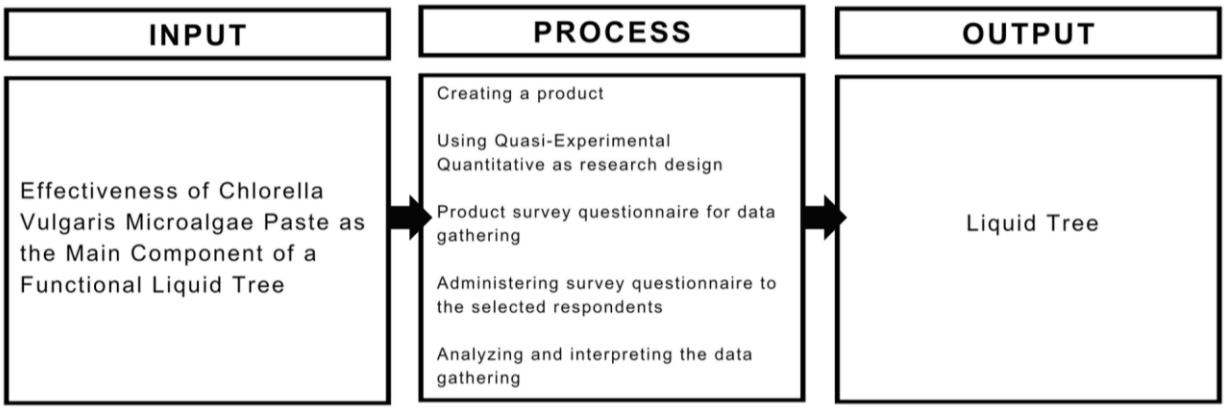
This study focuses on the effectiveness of Chlorella Vulgaris Microalgae Paste in creating a functional liquid tree. Additionally, the researchers attempt to find out the amount of Dissolved Oxygen (DO) present in the product to know if it effectively absorbs carbon dioxide. The researchers also attempt to find out if the Chlorella Vulgaris microalgae paste is suitable for absorbing CO2 and producing Oxygen.

This study will benefit the local environmental agencies as they can effectively implement the study to combat air pollution problems and improve air quality. Moreover, homeowners can utilize the product to enhance air quality, as the study focuses on the indoor environment, providing them with a better understanding of its components and functions. Lastly, future researchers can use the data gathered in this study as a guide or basis for improving their findings.

This study is anchored to the STochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model, a theory of Dietz and Rosa (1997) by reformulating the IPAT model into a stochastic equation. The study of Mcgee et al. (2015), states that environmental impacts are the result of the combined influence of population, affluence, and technological advancements. In the context of this study, the STIRPAT model indicates a strong correlation between the increasing level of urbanization and economic growth, which has the greatest impact on carbon dioxide emissions and air pollution, as stated by Bargaoui et al. (2014). By using the STIRPAT model, it provides a valuable framework to assess the impact of liquid trees on reducing carbon dioxide emissions and improving indoor air quality.

Figure 1.

Conceptual Paradigm



The researchers use the Input, Process, and Output Model (IPO Model) shown in Figure 1.1 as the conceptual research model. This illustrates the effectiveness of Chlorella Vulgaris microalgae paste as the main component of a functional liquid tree as the research's input, as well as the entire process of creating the liquid tree, including the data analysis and interpretation. This model also represents the liquid tree, which is the output of this research.

III. Methodology

The researchers employed a Quasi-experimental Research Design for this study. The majority of quasi-experiments, according to Hassan (2024) allows researchers to assess the causal linkages between variables while retaining some degree of control over the independent variables not possible in an actual experimental design. In this instance, the usefulness of using the liquid tree in place of a real tree for the absorption of CO2 and production of oxygen, especially in indoor areas, will be ascertained by the researchers through quantitative quasi-experimental methods. The

researchers searched for studies and research that show various methods of employing microalgae for CO2 capture and oxygen production.

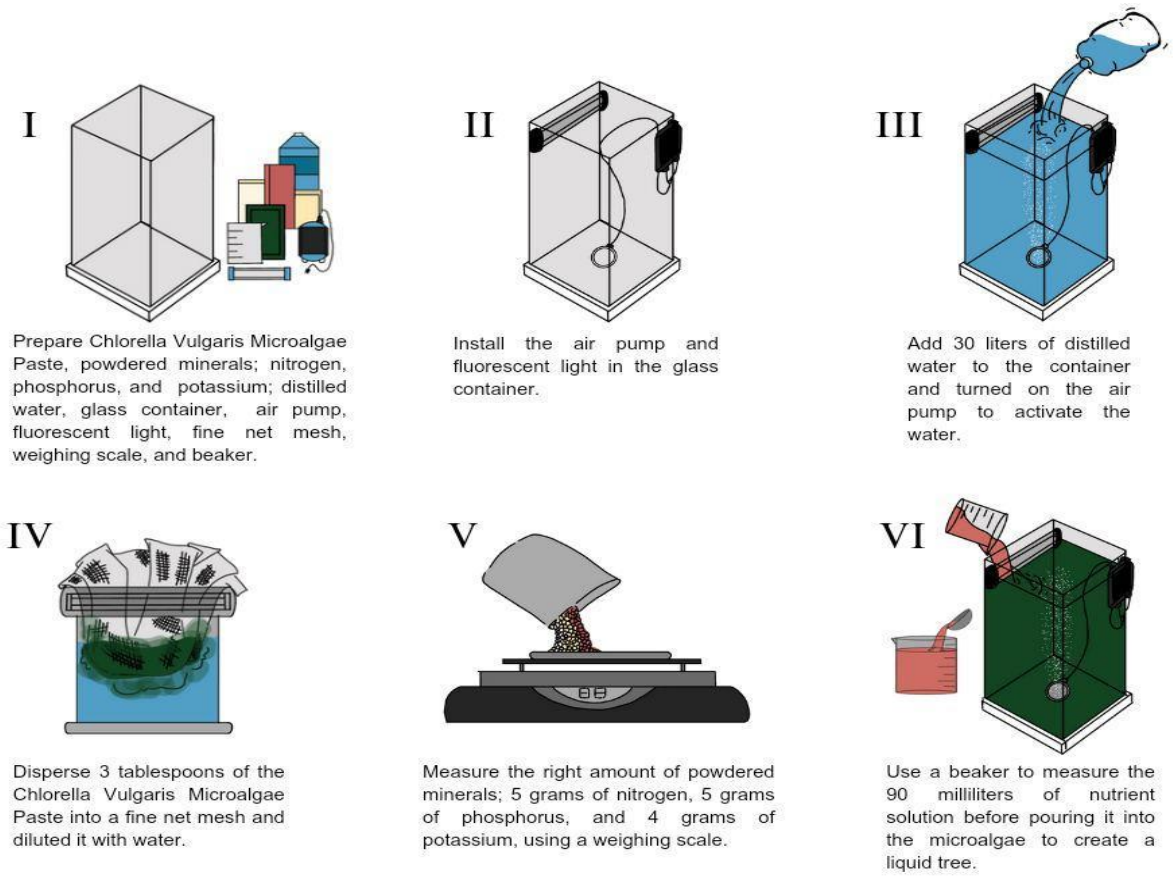
This study used a Purposive Sampling Technique to select the respondents based on the criteria that the researchers established. According to Rai & Thapa (2015), to collect observations from a broader population for a sample survey, a small group is selected to represent the complete population through the statistical technique of sampling. Thus, using the purposive sampling technique, 30 respondents were selected using the following criterias that the researchers established: (1) professionals in the field of biology and/or chemistry (2) has sufficient knowledge about microalgae, and; (1) homeowners residing in areas in Tagaytay City, Alfonso, and/or Silang (2) facing problems with indoor air quality.

The researchers selected the Santa Rosa Environmental Testing Laboratory to examine the function of the liquid tree. The professionals in the field of biology and/or chemistry of the said institution will be the respondents of the study since these professionals know how to determine the amount of dissolved oxygen present in the liquid tree. In addition, the respondents could also add recommendations and suggestions to improve the output of this study.

Using the previous studies as a guide, the researchers used Chlorella Vulgaris microalgae as the main component of a functional liquid tree. First, the researchers prepared Chlorella Vulgaris Microalgae Paste, powdered minerals; nitrogen, phosphorus, and potassium; distilled water, glass container, air pump, fluorescent light, fine net mesh, weighing scale, and beaker. Second, the researchers installed the air pump and fluorescent light in the glass container. For the third step, the researchers added 30 liters of distilled water to the container and turned on the air pump to activate the water. Moving on to the fourth step, the researchers dispersed 3 tablespoons of the Chlorella Vulgaris Microalgae Paste into a fine net mesh and diluted it with water. Fifth, the researchers measured the right amount of powdered minerals; 5 grams of nitrogen, 5 grams of phosphorus, and 4 grams of potassium, using a weighing scale. These powdered minerals were mixed together with a 1 liter of water to create a nutrient solution. Lastly, the researchers used a beaker to measure the 90 milliliters of nutrient solution before pouring it into the microalgae to create a liquid tree. These steps are illustrated below (Figure 2.2) for a clearer understanding of the procedure.

Figure 2.

Experiment Procedure



The researchers collected the data for the research study using a survey questionnaire. The use of this method is to ask questions to gather information about some particular issues or research topic. According to Nayak & Narayan (2019), as cited in the Oxford dictionary, a survey involves exploring the perspectives or experiences of a group of individuals using a series of questions, which can be divided into two categories; manual and electronic data collection method. This method is used to know the effectiveness of the liquid tree, as well as to gather the information that is needed for the study. In addition, the survey provides respondents with the opportunity to complete a closed-ended questionnaire, which helps researchers assess the respondents' views and insights.

The researcher used the weighted mean statistical treatment. The mean is used to determine the respondents' verbal interpretation of each sentence, and the mean score range is applied to reach a conclusive result:

Acceptability of the Liquid Tree and Chlorella Vulgaris Microalgae Paste

Scale Ranges	Qualitative Description
3.26 – 4.00	Highly Acceptable
2.51 - 3.25	Acceptable
1.76 - 2.50	Slightly Acceptable
1.00 - 1.75	Unacceptable

Effectiveness of the Liquid Tree

Scale Ranges	Qualitative Description
3.26 – 4.00	Highly Effective
2.51 - 3.25	Effective
1.76 - 2.50	Slightly Effective
1.00 - 1.75	Not Effective

Trial Table

Trial Number	Amount	Procedure	Results
Trial No. 1	**Water:** 1 Liter **Microalgae Paste:** 1 Tablespoon **Nutrient Solution (NPK):** 1 liter **Nitrogen:** 4 grams **Phosphorus:** 4 grams **Potassium:** 4 grams **Nutrient Media:** 1mL per Liter	**Water:** - The water is activated by adding aeration. This is done to prepare the microalgae cells for its reproduction in a new condition. **Microalgae Paste:** - After a couple of minutes, 1 tablespoon of microalgae paste is dissolved in water. **Nutrient Solution:** - The powdered minerals	The 1st Trial failed since the microalgae cells did not reproduce properly because it was directly dissolved in water without using a fine net mesh. The paste stays at the bottom of the container, indicating that it is already dead.

		were measured using a weighing scale. The Nitrogen, Phosphorus, and Potassium (NPK) are 4 grams respectively. - After measuring, it is mixed all together and then dissolved in water. **Nutrient Media:** - 1mL of the nutrient solution is added with the mixture of water and microalgae paste.	
Trial No. 2	**Water:** 10 Liters **Microalgae Paste:** 1 Tablespoon **Nutrient Solution (NPK):** 1 liter **Nitrogen:** 30 grams **Phosphorus:** 20 grams **Potassium:** 10 grams	**Water:** - The water is activated by adding aeration. This is done to prepare the microalgae cells for its reproduction in a new condition. **Microalgae Paste:** - 1 tablespoon of the microalgae paste is dissolved in water using a fine net mesh. **Nutrient Solution:** - The powdered minerals were measured using a weighing scale. 30g for Nitrogen, 20g for Phosphorus, and 10g for Potassium. - After measuring, it is mixed all together and then dissolved 1 liter of water. **Nutrient Media:** - 10mL (1mL per Liter) of the nutrient solution is added with the mixture of water and microalgae paste.	The 2nd Trial failed since the mixture only lasted for several days and its color is pale green which indicates that the cells do not reproduce properly. The nutrient ratio might be one of the factors that affects the lifespan of the liquid tree.
Trial No. 3	**Water (Culture Source):** 10 Liters	**Water:** - The water is activated by	

	Microalgae Paste: 1 Tablespoon **Nutrient Solution (NPK): 1 liter** **Nitrogen:** 30 grams **Phosphorus:** 20 grams **Potassium:** 10 grams	adding aeration. This is done to prepare the microalgae cells for its reproduction in a new condition. **Microalgae Paste:** - 1 tablespoon of the microalgae paste is dissolved in water using a fine net mesh. **Nutrient Solution:** - The powdered minerals were measured using a weighing scale. 30g for Nitrogen, 20g for Phosphorus, and 10g for Potassium. - After measuring, it is mixed all together and then dissolved in 1 liter of water.	
	Water: 1 Liter **Nutrient Media:** 1mL	**Water:** 1 liter of the mixture came from the culture source of 10 liters. **Nutrient Media:** 1mL of nutrient solution is added with the 1 liter mixture.	This trial failed because the mixture died after several days.
	Water: 1 Liter **Nutrient Media:** 2mL	**Water:** 1 liter of the mixture came from the culture source of 10 liters. **Nutrient Media:** 2mL of nutrient solution is added with the 1 liter mixture.	This trial failed because the mixture died after several days.
	Water: 1 Liter **Nutrient Media:** 3mL	**Water:** 1 liter of the mixture came from the culture source of 10 liters. **Nutrient Media:** 3mL of nutrient solution is added with the 1 liter mixture.	This trial failed because the mixture died after several days.
Trial No. 4	**Water (Culture Source):** 10 Liters **Microalgae Paste:** 1 Tablespoon	**Water:** - The water is activated by adding aeration. This is done to prepare the	

	Nutrient Solution (NPK): 1 liter **Nitrogen:** 5 grams **Phosphorus:** 5 grams **Potassium:** 4 grams	microalgae cells for its reproduction in a new condition. **Microalgae Paste:** - 1 tablespoon of the microalgae paste is dissolved in water using a fine net mesh. **Nutrient Solution:** - The powdered minerals were measured using a weighing scale. 5g for Nitrogen, 5g for Phosphorus, and 4g for Potassium. - After measuring, it is mixed all together and then dissolved in 1 liter of water. **Nutrient Media:** - 10mL (1mL per Liter) of the nutrient solution is added with the mixture of water and microalgae paste.	
	Water: 1 Liter **Nutrient Media:** 6mL	**Water:** 1 liter of the mixture came from the culture source of 10 liters. **Nutrient Media:** 1mL of nutrient solution is added with the 1 liter mixture. After a week, another 5mL of the NPK nutrients are added. A total of 6mL of nutrients are added in the mixture.	The trial lasted for a week. The color also changed from pale green to slightly dark green. However, there was a residue of microalgae paste, indicating that the cells were dead.
	Water: 1 Liter **Nutrient Media:** 7mL	**Water:** 1 liter of the mixture came from the culture source of 10 liters. **Nutrient Media:** 2mL of nutrient solution is added with the 1 liter mixture.After a week, another 5mL of the NPK nutrients are added. A total	This trial lasted for a week. The color also changes from pale green to a slightly dark green. But it had a residue of microalgae paste which indicates that the cells are dead.

		of 7mL of nutrients are added in the mixture.	
	Water: 1 Liter **Nutrient Media:** 8mL	**Water:** 1 liter of the mixture came from the culture source of 10 liters. **Nutrient Media:** 3mL of nutrient solution is added with the 1 liter mixture. After a week, another 5mL of the NPK nutrients are added. A total of 8mL of nutrients are added in the mixture.	The 3mL nutrient media that has been added with the mixture shows a promising result since it becomes darker green after 2-3 weeks, which indicates that the cells reproduce properly and the mixture absorbs carbon dioxide.
Trial No. 5	**Water: 30 Liters** **Microalgae Paste:** 1 Tablespoon **Nutrient Solution (NPK)**: 1 liter **Nitrogen:** 5 grams **Phosphorus:** 5 grams **Potassium:** 4 grams	**Water:** - The water is activated by adding aeration. This is done to prepare the microalgae cells for its reproduction in a new condition. **Microalgae Paste:** - 1 tablespoon of the microalgae paste is dissolved in water using a fine net mesh. **Nutrient Solution:** - The powdered minerals were measured using a weighing scale. 5g for Nitrogen, 5g for Phosphorus, and 4g for Potassium. - After measuring, it is mixed all together and then dissolved in water. **Nutrient Media:** - 120mL (40mL per 10 Liters) of the nutrient solution is added with the mixture of water and microalgae paste.	The fifth trial, which is also the sample used for dissolved oxygen testing, lasted for almost 2 weeks with 120 mL of nutrient media, and an additional 120 mL added before testing. The color of the microalgae also varied from light green to dark before becoming clear later on.

IV. Results

Problem 1: How effective is the mixture of water, Chlorella Vulgaris microalgae paste, and NPK (nitrogen, phosphorus, and potassium) as the main component of liquid tree?

Table 1.1

Effectiveness of Liquid Tree

Effectiveness of the Liquid Tree		
Indicators	**Weighted Mean**	**Verbal Description**
1. Liquid tree effectively decrease air pollution within indoor areas.	3.73	Highly Effective
2. The liquid tree demonstrates the effectiveness of capturing carbon dioxide throughout all indoor spaces.	3.87	Highly Effective
3. The liquid tree demonstrates the effectiveness of releasing oxygen throughout all indoor spaces.	3.80	Highly Effective
4. The liquid tree effectively captures a substantial amount of carbon dioxide within indoor spaces.	3.73	Highly Effective
5. The liquid tree can release a substantial amount of pure oxygen within indoor spaces.	3.70	Highly Effective
6. Maintaining the liquid tree demands minimal to zero assistance.	3.50	Highly Effective

Effectiveness of the Liquid Tree		
Indicators	**Weighted Mean**	**Verbal Description**
7. The liquid tree efficiently absorbs carbon dioxide and releases oxygen with no detrimental effects on the environment.	3.73	Highly Effective
8. The air pump of the liquid tree helps in maintaining its life.	3.70	Highly Effective
9. The liquid tree's ventilation system effectively aids in absorbing carbon dioxide and releasing oxygen.	3.77	Highly Effective
10. The liquid tree can function by itself with the fluorescent light.	3.73	Highly Effective
TOTAL	3.73	Highly Effective

Table 1.1 shows the effectiveness of the liquid tree. The statement with the highest weighted mean computed of – 3.87, states that the product is capable of capturing carbon dioxide throughout all indoor environments which is verbally interpreted as highly effective. The lowest weighted mean calculated states that maintaining a liquid tree requires minimal to zero assistance with 3.50 and was interpreted as highly effective. The overall weighted mean for the effectiveness of the liquid tree was 3.73, indicating that the product was highly effective. According to Raeesossadati (2014), microalgae emerges as a highly viable option for bioremediation across various CO2 emission sources. It boasts the remarkable ability to eliminate carbon dioxide at a rate of 10 to 50 times greater than that of land-based plants, mainly attributed to its higher chlorophyll concentration per surface area.

Table 1.2

Effectiveness of the Liquid Tree

Amount of Dissolved Oxygen

Samples	Time Interval	
	1 Hour	2 Hours
1 Day	7.96 ppm	8.05 ppm
11 Days	7.80 ppm	7.92 ppm

Table 1.2 shows the effectiveness of the liquid tree in terms of the amount of dissolved oxygen present in the product. The Day 1 sample has 7.96 ppm of dissolved oxygen after 1 hour of activation, and it increased to 8.05 ppm in the span of 2 hours. The 11 Days sample with the time interval of 1 hour after activation has 7.80 ppm of dissolved oxygen and it increased to 7.92 ppm after 2 hours. The results show that the amount of dissolved oxygen increases every hour. The standard range for the presence of dissolved oxygen is 5.00 ppm and the product has 7.00 to 8.00 ppm which clearly shows that it is above the minimum requirement. To support this statement, Sollanave (2019) stated that a healthy pond requires between 5 and 10 ppm of oxygen, and oxygen stress will occur if DO levels drop below 3 to 4 ppm.

Problem 2: What are the characteristics that can be observed in the liquid tree?

Table 2.

Size of the Liquid Tree

Characteristics of the Liquid Tree - Size		
Indicators	**Weighted Mean**	**Verbal Description**
1. The size of the liquid tree is suitable for an indoor environment.	3.77	Highly Acceptable

2. The size of the liquid tree is important when considering the amount of Microalgae that will be used.	3.90	Highly Acceptable
3. The liquid tree can be carried out from one place to another.	3.57	Highly Acceptable
TOTAL	**3.75**	**Highly Acceptable**

Table 2 illustrates the level of acceptability regarding the dimensions of the liquid tree. The highest computed weighted mean was 3.90, indicating that the size of the liquid tree is essential when considering the amount of microalgae that will be used. The lowest weighted mean computed states that the liquid tree can be transported from one location to another, with a weighted mean of 3.57. Overall, the size received a weighted mean of 3.75, signifying a high level of acceptability. According to Sutherland (2020), the productivity of microalgae is affected by the size, as well as the nutrient removal and biomass production.

Table 3.

Odor of the Liquid Tree

Characteristics of the Liquid Tree - Odor		
Indicators	**Weighted Mean**	**Verbal Description**
1. The mixture of the liquid tree has weak to no smell.	3.55	Highly Acceptable

Characteristics of the Liquid Tree - Odor		
Indicators	**Weighted Mean**	**Verbal Description**
2. The smell of the mixture in the liquid tree is tolerable.	3.69	Highly Acceptable
3. The odor of the mixture disappears quickly when dissolved in water.	3.79	Highly Acceptable
TOTAL	**3.68**	**Highly Acceptable**

Table 3 shows the acceptability for the odor of the liquid tree. The statement with the highest weighted mean computed of 3.79 in the table states that the odor of the product disappears quickly when dissolved in water. The lowest weighted mean computed states that the mixture of the liquid tree has weak to no smell with the weighted mean of 3.55 and was interpreted as highly acceptable. The overall weighted mean of the odor of the liquid tree was 3.68 which was verbally interpreted as highly acceptable. As a result, the overall evaluation of the product in terms of odor is highly acceptable.

Table 4.

Color of the Liquid Tree

Characteristics of the Liquid Tree - Color		
Indicators	**Weighted Mean**	**Verbal Description**
1. The color of the liquid tree indicates its state.	3.90	Highly Acceptable
2. The dark green color of the liquid tree indicates its vitality.	3.80	Highly Acceptable
3. The mixture of the liquid tree becomes greener when it absorbs carbon dioxide.	3.70	Highly Acceptable
TOTAL	**3.80**	**Highly Acceptable**

Table 4 shows the acceptability for the color of the liquid tree. The highest weighted mean received a total score of 3.90, which states that the color of the liquid tree indicates its state. The lowest computed weighted mean was 3.70, indicating that the liquid tree becomes greener when it absorbs carbon dioxide (CO2). Overall, the total weighted mean for the color of the liquid tree was 3.80, which can be verbally interpreted as highly acceptable. To support this, Amir et al. (2021) stated that the microalgae growth decreased on the final day of their observation, as indicated by the color of the water change. Chlorella vulgaris not only lowers the color but also decreases the pollutant load.

Table 5.

Eco-friendliness of the Liquid Tree

Characteristics of the Liquid Tree - Eco-friendliness		
Indicators	**Weighted Mean**	**Verbal Description**
1. The byproduct of the liquid tree can be used as a fertilizer.	3.73	Highly Acceptable
2. The components used for the liquid tree are environmentally friendly.	3.80	Highly Acceptable
3. The manufacturing process of the liquid tree does not pollute the environment.	3.80	Highly Acceptable
TOTAL	**3.78**	**Highly Acceptable**

Table 5 shows the acceptability for the eco-friendliness of the liquid tree. The statement with the highest weighted mean garnered – 3.80, which stated that the components used for the liquid tree are environmentally friendly and the manufacturing process of the product does not pollute the environment. Meanwhile, the statement with the lowest weighted mean of 3.73 states that the byproduct of the liquid tree can be used as a fertilizer. Overall, the total weighted mean of the gathered data is 3.78 which falls under the highly acceptable range. In conclusion, this may prove that the liquid tree is environmentally friendly. To support this statement, a study conducted by Onyeaka et al. (2021), microalgae possess the capacity to convert CO2 into bioenergy through photosynthesis, underscoring the environmentally sound and sustainable nature of utilizing microalgae for CO2 bioconversion.

Table 6.

Longevity of the Liquid Tree

Characteristics of the Liquid Tree - Longevity		
Indicators	**Weighted Mean**	**Verbal Description**
1. The life expectancy of the liquid tree is between 18-21 days.	3.60	Highly Acceptable
2. The lifespan of the liquid tree can be extended with the right ratio of NPK.	3.70	Highly Acceptable
3. The absence of light affects the life of the liquid tree.	3.80	Highly Acceptable
TOTAL	**3.70**	**Highly Acceptable**

Table 6 shows the acceptability for the longevity of the liquid tree. The statement with the highest calculated weighted mean was 3.80, states that the absence of light affects the life of the liquid tree which can be verbally interpreted as highly acceptable. On the other hand, the statement that has the lowest weighted mean states that the life expectancy of the liquid tree is between 18-21 days, with 3.60, and verbally interpreted as highly acceptable. Overall, the total weighted mean for the longevity of the liquid tree was 3.70 and is considered as highly acceptable. To support this statement, Chang et al. (2023) stated that the mixed algae culture could sustain itself for 3–7 days without additional digestate, which also depends on the outdoor weather conditions. The lifespan of the liquid tree can also be prolonged with the right ratio of NPK nutrients.

Problem 3: What is the level of acceptability of Chlorella Vulgaris Microalgae Paste as the main component of the Liquid Tree?

Table 7.

Odor of the Chlorella Vulgaris Microalgae Paste

Characteristics of the Chlorella Vulgaris Microalgae Paste - Odor		
Indicators	**Weighted Mean**	**Verbal Description**
1. The smell of the Chlorella Vulgaris microalgae paste is tolerable.	3.53	Highly Acceptable
2. The smell of the microalgae paste indicates its state.	3.47	Highly Acceptable
3. The odor of the microalgae paste disappears quickly when dissolved in water.	3.80	Highly Acceptable
TOTAL	**3.60**	**Highly Acceptable**

Table 7 shows the acceptability of the odor of the Chlorella Vulgaris Microalgae Paste as the main component of the Liquid Tree. The statement with the highest weighted mean garnered — 3.80, showing that the odor of the microalgae paste disappears quickly when dissolved in water. On the other hand, the statement with the lowest weighted mean garnered — 3.47 stated that the smell of the microalgae paste indicates its state. Overall, the total mean of the gathered data is 3.60 which is under the highly acceptable range.

Table 8.

Color of the Chlorella Vulgaris Microalgae Paste

Characteristics of the Chlorella Vulgaris Microalgae Paste - Color		
Indicators	**Weighted Mean**	**Verbal Description**
1. The color of the microalgae paste indicates its state.	3.73	Highly Acceptable
2. The green to dark green color of the microalgae paste indicates its cell's vitality.	3.87	Highly Acceptable

3. The color of the microalgae paste indicates its consistency.	3.77	Highly Acceptable
TOTAL	**3.79**	**Highly Acceptable**

Table 8 shows the acceptability of the color of the Chlorella Vulgaris Microalgae Paste as the main component of the Liquid Tree. The statement with the highest weighted mean garnered — 3.87, showing that the green to dark green color of the microalgae paste indicates its cell's vitality. Meanwhile, the lowest weighted mean garnered — 3.73 it stated the color of the microalgae paste indicates its state. Overall, the total mean of the gathered data is 3.79 which is under the highly acceptable range. According to Dolganyuk et. al (2020), microalgae are photodamaged when exposed to bright light, and some become pale green and decrease in size, showing a drop in chlorophyll density and affecting cell development.

Table 9.

Storage Life of the Chlorella Vulgaris Microalgae Paste

Characteristics of the Chlorella Vulgaris Microalgae Paste - Storage Life		
Indicators	**Weighted Mean**	**Verbal Description**
1. The microalgae paste can last for 3 months with proper storage.	3.53	Highly Acceptable
2. The microalgae paste can maintain its vitality if refrigerated in 0° to 5° temperature.	3.70	Highly Acceptable
3. The microalgae paste can maintain its vitality in a sealed container.	3.80	Highly Acceptable
TOTAL	**3.68**	**Highly Acceptable**

Table 9 shows the acceptability of the storage life of the Chlorella Vulgaris Microalgae Paste as the main component of the Liquid Tree. The statement with the highest weighted mean garnered — 3.80, showing that the microalgae paste can maintain its vitality in a sealed container. However, the lowest weighted mean garnered — 3.53 it stated that the microalgae paste can last for 3 months with proper storage. Overall, the total mean of the gathered data is 3.68 which is

under the highly acceptable range. In addition, this may prove that the Chlorella Vulgaris Microalgae Paste can last up to 3 months with proper storage and right temperature. To support this statement, Trinidad (2019) stated that the microalgae paste has a shelf life of three months from the time of production.

Table 10.

Overall Acceptability of the Liquid Tree and Chlorella Vulgaris Microalgae Paste

Indicators	Weighted Mean	Verbal Description
● Acceptability of the *size* of the *Liquid Tree*	3.75	Highly Acceptable
● Acceptability of the *odor* of the *Liquid Tree*	3.68	Highly Acceptable
● Acceptability of the *color* of the *Liquid Tree*	3.80	Highly Acceptable
● Acceptability of the *eco-friendliness* of the *Liquid Tree*	3.78	Highly Acceptable
● Acceptability of the *longevity* of the *Liquid Tree*	3.70	Highly Acceptable
● Acceptability of the *odor* of the *Chlorella Vulgaris Microalgae Paste*	3.60	Highly Acceptable
● Acceptability of the *color* of the *Chlorella Vulgaris Microalgae Paste*	3.79	Highly Acceptable
● Acceptability of the *storage life* of the *Chlorella Vulgaris Microalgae Paste*	3.68	Highly Acceptable

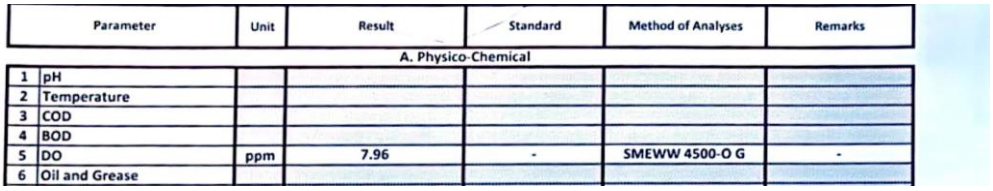
Indicators	Weighted Mean	Verbal Description
GRAND MEAN	**3.72**	**Highly Acceptable**

The Table 10 shows the overall acceptability for the liquid tree and the Chlorella Vulgaris microalgae paste. Based on the results, the total weighted mean was 3.72, indicating that the liquid tree and Chlorella Vulgaris microalgae paste is highly acceptable in terms of its characteristics.

Figure 3.1

Dissolved Oxygen Testing Results

1 Day Sample (1 Hour After Activation)

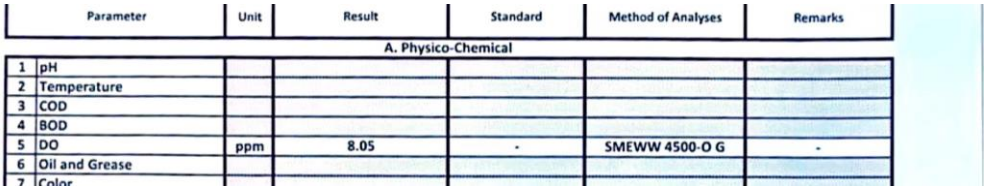


	Parameter	Unit	Result	Standard	Method of Analyses	Remarks
	A. Physico-Chemical					
1	pH					
2	Temperature					
3	COD					
4	BOD					
5	DO	ppm	7.96	-	SMEWW 4500-O G	-
6	Oil and Grease					

Figure 3.2

Dissolved Oxygen Testing Results

1 Day Sample (2 Hours After Activation)

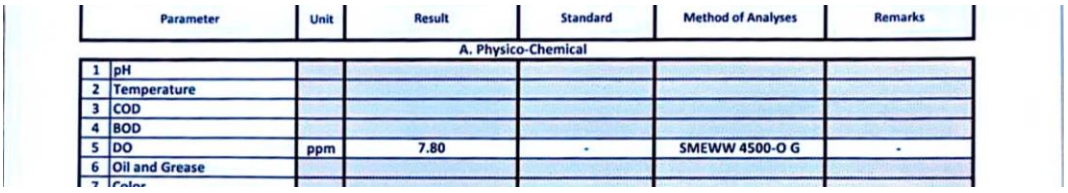


	Parameter	Unit	Result	Standard	Method of Analyses	Remarks
	A. Physico-Chemical					
1	pH					
2	Temperature					
3	COD					
4	BOD					
5	DO	ppm	8.05	-	SMEWW 4500-O G	-
6	Oil and Grease					
7	Color					

Figure 3.3

Dissolved Oxygen Testing Results

11 Days Sample (1 Hour After Activation)



	Parameter	Unit	Result	Standard	Method of Analyses	Remarks
	A. Physico-Chemical					
1	pH					
2	Temperature					
3	COD					
4	BOD					
5	DO	ppm	7.80	-	SMEWW 4500-O G	-
6	Oil and Grease					
7	Color					

Figure 3.4

Dissolved Oxygen Testing Results

11 Days Sample (2 Hours After Activation)

	Parameter	Unit	Result	Standard	Method of Analyses	Remarks
	A. Physico-Chemical					
1	pH					
2	Temperature					
3	COD					
4	BOD					
5	DO	ppm	7.92	-	SMEWW 4500-O G	-
6	Oil and Grease					
7	Color					

V. Discussion

The purpose of this study is to determine the effectiveness of Chlorella Vulgaris Microalgae Paste in a functional Liquid Tree. The data collected showed that the respondents had a nearly favorable attitude toward the outcome of the study. Overall, the results show the effectiveness of the liquid tree, garnering a total weighted mean of 3.83 (highly effective). In terms of its characteristics, the liquid tree also shows a highly acceptable range, with its size having a total weighted mean of 3.75 (highly acceptable), the odor with a total weighted mean of 3.68 (highly acceptable), the color with a total weighted mean of 3.80 (highly acceptable), the eco-friendliness with a total weighted mean of 3.80 (highly acceptable), and the longevity having a total weighted mean of 3.70 (highly acceptable). Additionally, the characteristics of the Chlorella Vulgaris Microalgae Paste also show a highly acceptable range, with its odor having a total weighted mean of 3.60 (highly acceptable), the color with a total weighted mean of 3.79 (highly acceptable), and the storage life that has a total weighted mean of 3.68 (highly acceptable). Garnering a total weighted mean of 3.74 overall, the researchers achieved highly effective and highly acceptable results. Moreover, the results of the testing for the amount of Dissolved Oxygen (DO) revealed that in the first trial, the 1-day mixture had 7.96 ppm, one hour after the cell activation; in the second trial increased to 8.05 ppm after two hours. On the other hand, the 11-day mixture revealed a total of 7.80 ppm of DO after one hour of cell activation, and 7.92 ppm after two hours. The findings indicate that there is an hourly increase in the dissolved oxygen content. The presence of dissolved oxygen shows that the liquid tree was able to absorb CO2. To support this statement, Huang (2017) stated that much of the DO is released as a byproduct of photosynthesis. Microalgae can only undergo a photosynthetic process by capturing CO2 and

sunlight, this statement can be supported by the study of Miranda (2022) which states that microalgae are defined as photosynthetic microorganisms that use CO2 and sunlight to obtain oxygen.

The findings of this study are restricted to indoor environments due to the liquid tree's small capacity of 30 liters. It should be noted that this study only examined the effectiveness of the liquid tree and its observed characteristics such as size, odor, color, eco-friendliness, and longevity, as well as its effectiveness in terms of the amount of DO. It also examines the observed characteristics of Chlorella Vulgaris microalgae paste such as odor, color, and storage life. Furthermore, the microalgae paste should be activated first for at least 2-3 days before it can properly reproduce. Additionally, the right ratio of nutrient solution should be considered since it can affect the growth and the function of the microalgae. Lastly, the glass is important because of its transparency which allows the light to pass through.

Finally, the researchers recommend that more in-depth research should be undertaken. The future researchers about the liquid tree can focus on finding out the exact amount of Carbon Dioxide (CO2) that it can absorb, as well as the exact amount of Oxygen that will be released by the liquid tree. Additionally, the researchers suggest using a solar panel for the source of energy that the air pump and artificial light needs for the sustainability of the product. Moreover, future researchers can also consider using another species of microalgae that is capable of absorbing CO2 through a photosynthetic process.

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Effectiveness of Eggshell Wastes, Dried Banana Leaves, and Dried Guava Leaves as Biosorbent Tea Bag

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I. Abstract

Metallic element water contamination poses a significant global challenge, threatening human health and ecosystems. Therefore, this study aimed to investigate the effectiveness of biosorbent tea bag composed of powdered eggshells, dried banana leaves, and dried guava leaves in adsorbing heavy metal, metal, or metalloid ions from water. The researchers utilized a quantitative quasi-experimental research design, and employed purposive sampling to select survey respondents with specific criterias: (1) water testing professionals, (2) homeowners in Cavite, and (3) science teachers in Tagaytay City, all aged 18 or above. The researchers created a biosorbent tea bag by combining powdered eggshells, dried banana leaves, and dried guava leaves enclosed in a porous tea bag pouch, aiming to adsorb heavy metal, metal, or metalloid ions from water samples through a convenient and chemical-free way. The statistical treatment used was the weighted mean, with results interpreted as effective and acceptable for each indicator. The researchers found that the biosorbent tea bag was effective and also highly acceptable in terms of appearance, odor, storage life, eco-friendliness, while it is effective in terms of cost-friendliness. Based on the experiments, the large size tea bag containing approximately 7 grams of powdered mixture can only adsorb metallic ions, particularly Boron (B), in a 1000mL volume of water with a mean treatment efficiency of 4.52%. Thus, it is considered effective. Despite the positive results, the researchers suggest using more heavily contaminated water in testing, to utilize other natural materials in biosorption, and to include post-treatment methods to further make the treated water potable.

Keywords: *biosorbent tea bag, plant adsorbent, metallic elements, water treatment*

II. Introduction

Water contamination is a widespread issue all around the world, which can be caused by natural or man-made activities. Dangerous chemicals and microorganisms contaminate water bodies, further deteriorating water quality and rendering it unsafe for consumption. As highlighted in the findings of Singh et al. (2022), the contamination of water bodies by heavy metals and metalloids is currently a pressing concern across various sources such as lakes, rivers, groundwater, and more. According to Zhang et al. (2023), heavy metals such as Chromium (Cr), Cadmium (Cd), Lead (Pb), Arsenic (As), Mercury (Hg), Nickel (Ni), and Copper (Cu) have been associated with numerous health problems in humans, including liver failure, kidney damage, various forms of cancer, and reproductive issues; while Li et al. (2014) highlighted the adverse impacts of metals and metalloids such as Chromium (Cr), Copper (Cu), Lead (Pb), Boron (B), and Selenium (Se) on microorganisms, plants, and animals when present in water. As reported by the Water Environment Partnership in Asia (2023), rapid urbanization has caused many waterborne health crises, forcing sanitation demands on governments. Also, Perelonia et al. (2017) identified concerning patterns of heavy metal element contamination in Philippine water sources, particularly in areas like Northern and Southern Bataan, Eastern and Western Bulacan, and Cavite; these locations were found to have heavy metal levels higher than those allowed by the Department of Environment and Natural Resources (DENR). Addressing this issue, wastewater treatment systems emerged into play, and as noted by Priyadharshini et al. (2020), it further evolved by integrating natural methods and materials to offer cost-effective solutions for cleaner water sources. Thus, creating a biosorbent powder could function as a viable and low-cost solution in solving cases of heavy metal contamination in water. Concerning this, millions of solid eggshell waste are generated yearly as per the study of Waheed et al. in 2020. Scientifically, eggshells are composed of 94% Calcium Carbonate ($CaCO3$) and exhibit notable ion exchange capabilities—while dried leaves, particularly banana and guava, possess significant adsorbent properties due to the presence of various organic compounds, such as tannins and lignin. In this case, the researchers propose combining eggshells with dried banana and guava leaves to create a biosorbent tea bag capable of adsorbing heavy metal, metal, or metalloid ions from water.

Several notable studies have dived into the utilization of eggshells and other natural materials as adsorbents for various water sources. However, these investigations include variations in the process and methods of creating the adsorbent. Norul & Nuramidah (2021) demonstrated

the effectiveness of eggshell biosorbent powder by combining and activating it with Sulfuric Acid (H2SO4). On the other hand, the researchers aim to create an effective eggshell biosorbent powder without the use of additional chemicals. Moreover, the study of Herlinawati et al. (2022) utilized pineapple leaves as an adsorbent base as it has the presence of carbon compounds, such as cellulose and lignin. In contrast, the researchers aim to use banana and guava leaves as an alternative as they offer the advantage of being more readily available as they can be seen everywhere and are cost-effective. Although, both pineapple, banana, and guava leaves boast a rich array of organic compounds, including cellulose, lignin, and various phenolic compounds, which contribute to their capability of forming strong chemical bonds with metallic element ions present in water to facilitate effective adsorption, the porous structure of banana and guava leaves provides a large surface area for adsorption. Furthermore, this research also seeks to innovate by combining eggshell with banana and guava leaves as the biosorbent material to further enhance adsorption ability, presenting a different approach in contrast to earlier studies. In addition, addressing the recommendation of Norul & Nuramidah (2021), which highlights the need for easier handling of biosorbent powders, our approach involves incorporating powdered eggshell, dried banana leaves, and dried guava leaves into a tea bag style pouch to facilitate practical application.

Consequently, Filipenco (2023) said that hazardous substances and microbes pollute water sources, worsening the water quality and rendering it unfit for human consumption. This highlights the urgent need for an efficient, and affordable water treatment method. Numerous existing studies have already concluded that eggshells and other plant-based materials can be used as adsorbents of heavy metals in water. However, these existing studies show various processes and problems - such as the use of chemicals in activation and do not facilitate easy handling. Therefore, the purpose of this quantitative research was to know the effectiveness of eggshells, dried banana leaves, and dried guava leaves as adsorbents. Additionally, the study specifically targeted metallic element ions in water by evaluating the adsorbent capabilities of the variables as powdered biosorbent. The result of this study could be beneficial to the community, providing a sustainable and practical solution to water contamination challenges.

This study aimed to answer the following questions:

1. **How effective is the mixture of eggshells, dried banana leaves, and dried guava leaves as a biosorbent tea bag?**

2. **What is the composition of the biosorbent tea bag?**
    - **2.1 How much eggshells, dried banana leaves, and dried guava leaves are proportionally used in the biosorbent tea bag?**
    - **2.2 What are the specific ratios of eggshells, dried banana leaves, and dried guava leaves required to create an effective biosorbent tea bag?**
3. **How acceptable is the biosorbent tea bag in terms of:**
    - **3.1 appearance,**
    - **3.2 odor,**
    - **3.3 storage life,**
    - **3.4 eco-friendliness,**
    - **3.5 cost-effectiveness?**

This research focused on the effectiveness of powdered eggshells, dried banana leaves, and dried guava leaves as a biosorbent tea bag for metallic element ions in water. In addition, the research exclusively involved testing water samples gathered from the nearest river, Lian Eco-Park, which is located in Lian, Batangas, to assess the effectiveness of the biosorbent tea bag.

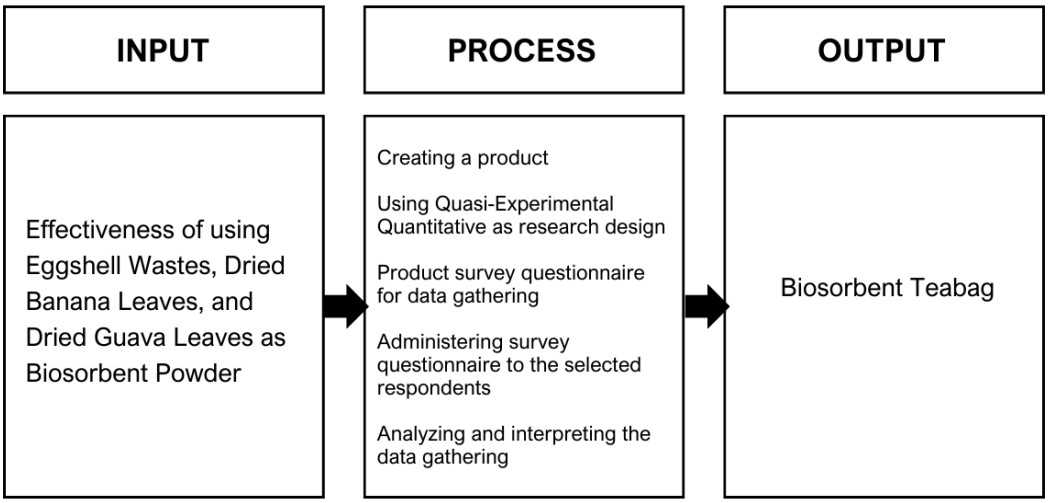
Additionally, the researchers sought to measure the concentration of heavy metal, metal, and metalloid ions in the water samples and measure the effectiveness of a specified amount of powder contained within the tea bag, when used with a specific volume of water, in reducing the levels of element ion concentration in water. This was done through the use of a machine called an Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES), which can be used to determine how much certain elements are in a sample. In this phase, water testing professionals were encouraged to contribute their expertise in identifying and quantifying the specific metallic element ions present in the water samples used for testing.

This study will help the **community**, particularly those in rural areas, by providing an accessible solution for obtaining uncontaminated and safe water through the convenient application of the biosorbent powder tea bag. The cost-effectiveness of this method makes it a practical option for communities with limited water resources, addressing a crucial need for clean water in these regions. Furthermore, **water treatment professionals** will also benefit from the results gained in this study, as it offers a natural and efficient pre-distillation method to combat water contamination. And lastly, it lays the foundation for **future researchers**' study and refinement of biosorption techniques, stimulating a collective effort towards enhanced water quality solutions.

This study was supported by Circular Economy (CE), a theory turned practice, which was initially shaped by Walter R. Stahel in the 1970s and continually improved through the years from the contributions of various scholars. The CE theory, as outlined by Patel et al. (2022), includes waste reduction, reuse and recycling of materials, and fosters a closed-loop system that minimizes environmental impact. By applying its principles, the researchers aim to create sustainable solutions that minimize environmental impact and promote resource efficiency in water treatment processes through utilizing eggshells, dried banana leaves, and dried guava leaves as heavy metal, metal, and metalloid ion adsorbents. Furthermore, Madeła & Skuza (2021) have also used the CE framework in their previous studies on adsorbents, demonstrating its effectiveness in enhancing sustainable solutions for water treatment processes.

Figure 1.

Conceptual Paradigm



The researchers utilized the Input, Process, and Output Model (IPO Model) presented in Figure 1 as the conceptual research model. This showed the effectiveness of eggshells, dried banana leaves, and dried guava leaves as biosorbent powder as the input of the research and demonstrated the starting process of making the biosorbent powder as the product until the analysis and interpretation of the data collected. In addition, this model represented the output of this research—the biosorbent tea bag.

III. Methodology

The researchers utilized a Quasi-Experimental Design in conducting this research. According to Miller et al. (2020), Quasi-Experimental Designs enable implementation scientists to conduct rigorous studies with limitations. In this case, the researchers used this design to determine the effectiveness of combined eggshells, dried banana leaves, and dried guava leaves in creating a biosorbent tea bag. The researchers started by finding problems encountered globally, and water contamination due to toxic substances like heavy metals is one of them. The researchers looked for studies and articles that examine the process of treating contaminated water through natural means.

The researchers conducted this study using a Purposive Sampling Technique. This strategy is non-probability sampling where one makes a conscious decision on what the sample needs to include and chooses participants accordingly. As mentioned by Campbell et al. (2020), it is utilized to select respondents who are most likely to give appropriate and useful information to the research. Thus, using the purposive sampling technique, the researchers made criteria that the respondents should meet: water testing professionals, without geographical limitation, aged 18 or above; homeowners residing specifically in Cavite, aged 18 or above; and teachers in Tagaytay City, aged 18 or above and are currently teaching science-related subjects.

The researchers selected water testing professionals, specifically from Santa Rosa Environmental Testing Laboratory, to be the respondents of the study as they can provide insights into water quality assessment and recommendations for improving the biosorption method. They were also invited to assist the researchers in testing the water samples. Similarly, homeowners from Cavite and science teachers from Tagaytay City, were also selected, as homeowners' experience with local water sources offers practical insights, while science teachers contribute their expertise in science education to further enhance the research.

Based on the previous studies, the researchers decided to utilize eggshells, dried banana leaves, and dried guava leaves as biosorbent powder. For the process, the researchers collected eggshells from diverse sources such as households, eateries, or bakeries, alongside gathering banana and guava leaves from the surroundings. To prepare the eggshells, they were washed using distilled water to eliminate impurities and remove the eggshell membrane residues. After that, the cleaned eggshells were sun and air-dried for a minimum of two hours. To ensure the denaturation of any remaining natural materials and to extend shelf life, the eggshells were also oven-dried at

120°C for 15-20 minutes. This process helped in expanding the surface area of the eggshell, which is relevant to its adsorption capability. Next, the eggshells were crushed using a coffee grinder and were then sieved to achieve powder-sized particles. On the other hand, the banana and guava leaves were also washed with distilled water to eliminate the impurities and were left to air and sun-dry for at least 3-5 days. The dried banana leaves and dried guava leaves underwent oven-drying at 120°C for 20 minutes to both dry and denature the leaves, as well as to expand the leaves' surface area. Once completely dried, both the dried banana leaves and dried guava leaves were cut into small pieces, crushed using a coffee grinder, and sieved to attain powder-sized particles. Finally, the powdered eggshell, dried banana leaves, and dried guava leaves were combined, which were then packed within a tea bag-style pouch for convenient use.

The biosorbent tea bag, made from powdered eggshells, dried banana leaves, and dried guava leaves, presented a promising solution for heavy metal, metal, or metalloid ion removal. During the initial experimentation, researchers found that the precise application and required quantity of the tea bag remained uncertain as the researchers were only able to test a tea bag containing approximately 7 grams of powder in a 1000mL water sample. Further experimentation is necessary to determine the exact amount of powder enclosed in a tea bag needed for effective use in specified water volumes. Additionally, the anticipated storage life of the tea bag is expected to be a minimum of 2 years, given its natural composition, although proper storage in dry conditions is crucial for maintaining effectiveness.

Product Making Trials

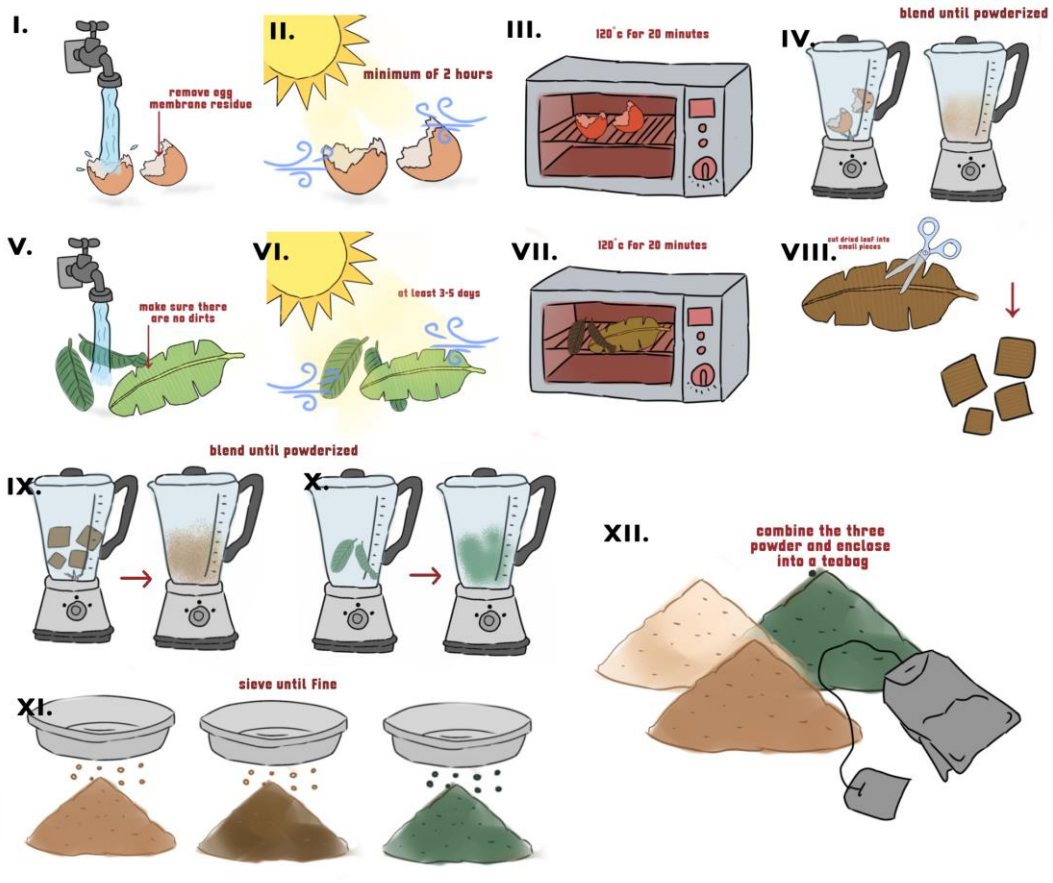
Trial Number	Amount	Procedure	Results
1	Approximately 7 grams	**Eggshells**: ● Ovened only for a short period and low temperature (5 minutes; 50℃) ● Eggshell membrane is not removed ● Some eggshells are wet **Banana Leaves**: ● Ovened only for a short period and low temperature (10 minutes; 50℃)	**Eggshells:** ● Still had bad odor due to the retained eggshell membrane ● Harder to grind into fine-sized powder, particles are coarser **Banana Leaves:** ● Harder to sieve enough for finer particles

		Guava Leaves: ● Ovened only for a short period and low temperature (10 minutes; 50℃) ● Veins and midribs are not removed	**Guava Leaves:** ● Harder to sieve enough for finer particle
2	Approximately 7 grams	**Eggshells**: ● Ovened for 15-20 minutes in 120℃ ● Eggshell is washed thoroughly and membrane removed prior to air/sun drying **Banana Leaves**: ● Sun and air dried prior to day of Trial 2 ● Ovened for 15-20 minutes in 120℃ ● Sieved repeatedly **Guava Leaves:** ● Sun and air dried prior to day of Trial 2 ● Ovened for 15-20 minutes in 120℃ ● Veins and midribs are removed. ● Sieved repeatedly **Overall (Teabag):** ● Enclosed into the tea bag without equal and appropriate mixture ratio	**Eggshells**: ● Easier to grind and sieve into finer particles after ovening due to the 'crispy' texture after removal of membrane ● Bad odor is removed **Banana Leaves**: ● Due to the 'crispy' texture, the banana leaves became easier to grind ● Fine-sized particles achieved **Guava Leaves:** ● Due to the 'crispy' texture, the guava leaves became easier to grind ● Fine-sized particles achieved **Overall (Teabag):** ● Too powdery that the powder leaks from the tea bag, strong and unequal odor
3	Approximately 7 grams	**All:** ● Same process as in the Trial 2, but less sieving **Overall (Teabag):** ● Equal ratio of mixture 1:2 [1 spoon of mixed dried banana leaves powder, and	**All:** ● Particle size is enough for the tea bag to not easily leak **Overall (Teabag):** ● Odor became tolerable

		dried guava leaves powder, 2 spoons of eggshell powder]	• The tea bag does not leak that much anymore

Figure 2.

Experiment Procedure



These steps are illustrated below (Figure 2) for a clearer understanding of the procedure.

Before conducting a survey to collect data, the researchers sought permission from the principal. After requesting permission, the approval was sent to the selected participants who met the criteria provided by the researchers. The researchers collected the data for the research study

using a survey questionnaire. This method helped in determining the effectiveness of the powdered eggshells, dried banana leaves, and dried guava leaves mixture as a biosorbent tea bag. Furthermore, the survey included an option for respondents to respond as well as a closed-ended questionnaire that assisted the researchers in evaluating their views and insights.

The researchers used the weighted mean as the statistical treatment. Wherein, the mean would be used to establish the respondents' verbal interpretation of each sentence, and the mean score range was employed to arrive at a definitive result.

Effectiveness of the Biosorbent Tea Bag

Scale Ranges	**Qualitative Description**
3.26 – 4.00	Highly Effective
2.51 – 3.25	Effective
1.76 – 2.50	Slightly Effective
1.00 – 1.75	Not Effective

Acceptability of the Characteristics of the Biosorbent Tea Bag

Scale Ranges	**Qualitative Description**
3.26 – 4.00	Highly Acceptable
2.51 – 3.25	Acceptable
1.76 – 2.50	Slightly Acceptable
1.00 – 1.75	Unacceptable

IV. Results

Problem 1. How effective is the mixture of eggshells, dried banana leaves, and dried guava leaves as a biosorbent tea bag?

Table 2.

Effectiveness of Biosorbent Tea Bag

Indicators	Weighted Mean	Verbal Interpretation
1. The biosorbent tea bag effectively reduces heavy metal, metal, or metalloid ion concentration in the water samples of the same volume.	2.87	Effective
2. The biosorbent consistently produces a substantial amount of adsorption to eliminate heavy metal, metal, or metalloid ions from water.	2.60	Effective
3. The biosorbent tea bag demonstrates a significant decrease in heavy metal, metal, or metalloid ion concentration post-treatment compared to pre-treatment.	2.73	Effective
4. The biosorbent, when used in the tea bag-style pouch, is successful in adsorbing heavy metal, metal, or metalloid ions found in water.	2.77	Effective
5. The biosorbent tea bag exhibits consistent adsorption capacity in individual treatments.	2.80	Effective
6. The biosorbent tea bag effectively adsorbs a range of heavy metal, metal, or metalloid ions commonly found in water.	2.53	Effective
7. The tea bag-style pouch ensures easy disposal of used biosorbent without causing harm to the environment.	3.13	Effective
8. The biosorbent tea bag does not introduce secondary pollutants or negatively impact water quality during the adsorption process.	2.63	Effective
GRAND MEAN	**2.76**	**Effective**

Table 2 shows the effectiveness of biosorbent tea bag. The statement indicating the highest weighted mean computed in the table states that the product ensures easy disposal of used

biosorbent without causing harm to the environment, accumulating a 3.13 weighted mean which was verbally interpreted as effective. The lowest computed mean which states that numerous common heavy metal, metal, and metalloid ions found in water were efficiently adsorbed by the biosorbent tea bag had a weighted mean of 2.53 and was interpreted as effective. The overall weighted mean computed for the effectiveness of biosorbent tea bag is 2.76 which was verbally interpreted as effective. To support this statement, according to Mignardi et al. (2020) the utilization of eggshells in creating an adsorbent contributes to a more sustainable and effective management of this biowaste, similarly Adeniyi & Ighalo (2019) also underlined that plant leaves are great materials to make precursors for the creation of effective biosorbents. Furthermore, addressing the recommendations of Norul & Nuramidah (2021) to enhance usability, the incorporation of a tea bag-style pouch by the researchers aligns with making the adsorbent more convenient for use. Hence, the findings confirm that the adsorbent tea bag effectively adsorbed contaminants, therefore suggesting its potential as a solution for water treatment.

Problem 2. What is the composition of the biosorbent tea bag?

2.1 How much eggshells, dried banana leaves, and dried guava leaves are used to make the adsorbent powder mixture?

2.2 What are the specific ratios of eggshells, dried banana leaves, and dried guava leaves in the biosorbent tea bag

Table 3.

Composition of the Biosorbent Tea Bag

Size of Tea Bag	Component	Amount Used for Adsorbent Powder Mixture	Specific Ratio in Tea Bag
LARGE	Eggshells	Approximately 3.5 grams	50%
	Dried Banana Leaves	Approximately 1.75 grams	25%
	Dried Guava Leaves	Approximately 1.75 grams	25%

Table 3 shows that the biosorbent tea bag in large size has approximately 7 grams of adsorbent powder mixture, which consists of approximately 3.5 grams of eggshells, approximately 1.75 grams of dried banana leaves, and also 1.75 grams of dried guava leaves. Additionally, the tea bag contains a specific ratio of 1 is to 2 to balance out the mixture of the leaves and eggshell component. It is important to note that while the researchers also produced other sizes of tea bags, only the large size was utilized in the experiments.

Problem 3. How acceptable is the biosorbent tea bag in terms of appearance, odor, storage life, eco-friendliness, and cost-effectiveness?

Table 4.1

Appearance of Biosorbent Tea Bag

Acceptability of the Biosorbent Tea Bag		
Indicator - Appearance	**Weighted Mean**	**Verbal Interpretation**
1. The visual appearance of the biosorbent tea bag is appealing.	3.50	Highly Acceptable
2. The color of the tea bag is suitable for its intended use.	3.50	Highly Acceptable
3. The texture of the tea bag is uniform and consistent.	3.50	Highly Acceptable
4. The size and shape of the tea bag are optimized for easy handling and application in water treatment processes.	3.53	Highly Acceptable
5. The overall presentation of the tea bag, including packaging and labeling, enhances its visual appeal and communicates key information effectively to users.	3.37	Highly Acceptable
GRAND MEAN	**3.48**	**Highly Acceptable**

Table 4.1 shows the acceptability of the biosorbent tea bag in terms of appearance. The statement that shows that the size and shape of the product are optimized for easy handling and application in water treatment processes has the highest computed weighted mean of 3.53, which

is verbally interpreted as highly acceptable. On the other hand, the lowest computed weighted mean that stated the overall presentation of the tea bag, in terms of packaging and labeling, visual appeal, and effective deliberation of key information to users, got a weighted mean of 3.37 which is verbally interpreted as highly acceptable. The total weighted mean for the acceptability of the appearance of the biosorbent tea bag is 3.48, which was verbally interpreted as highly acceptable. To support this statement, Gusain et al. (2021) emphasized in their study that the adsorbents' physical characteristics, including appearance, are one of the factors determining the effectiveness of treating hazardous and heavy metal-containing water and wastewater via adsorption. Hence, having a biosorbent tea bag with the appropriate appearance offers a huge advantage to its functionality.

Table 4.2

Odor of Biosorbent Tea Bag

Acceptability of the Biosorbent Tea Bag		
Indicator - Odor	**Weighted Mean**	**Verbal Interpretation**
1. The odor of the biosorbent tea bag is subtle and natural.	3.60	Highly Acceptable
2. The natural fragrance of the tea bag enhances its appeal and complements its eco-friendly composition.	3.67	Highly Acceptable
3. The natural odors from eggshells, dried banana leaves, and dried guava leaves in the tea bag are tolerable.	3.53	Highly Acceptable
4. The tea odor of the tea bag dissipates quickly upon immersion in water, leaving behind no residual scent.	3.27	Highly Acceptable
5. The odor of the tea bag is non-intrusive and subtle, allowing for comfortable use in various water treatment settings.	3.20	Acceptable
GRAND MEAN	**3.45**	**Highly Acceptable**

Table 4.2 illustrates the acceptability of the biosorbent tea bag in terms of odor. The statement with the highest weighted mean of 3.67 indicates that the natural fragrance of the tea bag enhances its appeal and aligns with its eco-friendly composition, which is verbally interpreted as highly acceptable. In contrast, the statement with the lowest weighted mean of 3.20 states that the odor of the tea bag is non-intrusive and subtle, making it suitable for comfortable use across various water treatment settings, and this is verbally interpreted as acceptable. The overall weighted mean for the odor of the biosorbent tea bag is 3.45, indicating that the product attains a highly acceptable rating concerning its odor characteristics. To support this statement, previous research by Luca & Botelho (2019) has indicated that odors play a significant role in shaping consumers' responses towards both products and surroundings. Considering that the odor of the biosorbent powder in a tea bag is based on natural odors, it likely triggers positive associations and sensory experiences, contributing further to its overall acceptability among users.

Table 4.3

Storage Life of Biosorbent Tea Bag

Acceptability of the Biosorbent Tea Bag		
Indicator - Storage Life	**Weighted Mean**	**Verbal Interpretation**
1. The biosorbent tea bag has a long shelf life, due to the stability of its natural ingredients.	3.43	Highly Acceptable
2. The tea bag maintains its stability and performance over time.	3.20	Acceptable
3. The tea bag is resistant to moisture, ensuring its effectiveness during a prolonged period.	3.33	Highly Acceptable
4. The tea bag can be stored conveniently in various environments without compromising its effectiveness.	3.40	Highly Acceptable
5. Proper storage conditions, such as dry and cool environments, further contribute to the shelf life of the tea bag.	3.57	Highly Acceptable
GRAND MEAN	**3.39**	**Highly Acceptable**

Table 4.3 indicates the acceptability of the biosorbent tea bag in terms of storage life. The statement that shows that the biosorbent tea bag has a long shelf life due to the stability of its natural ingredients, had a highest computed weighted mean of 3.57, which is verbally interpreted as highly acceptable. On the other hand, the stability of the tea bag and performance over time had the lowest computed weighted mean of 3.20 which was verbally interpreted as acceptable. The overall weighted mean for the acceptability of biosorbent tea bag is 3.39, which is verbally interpreted as highly acceptable. To support this statement, Petikirige et al. (2022) briefly mentioned in their study that the process of drying, which was done by the researchers, reduces microbial growth and increases shelf life of natural materials like fruits, or in terms of this study, leaves. Hence, this finding suggests that the biosorbent tea bag, with its natural ingredients and drying process, offers favorable storage life characteristics, contributing to its overall acceptability.

Table 4.4

Eco-friendliness of Biosorbent Tea Bag

Acceptability of the Biosorbent Tea Bag		
Indicator - Eco-friendliness	**Weighted Mean**	**Verbal Interpretation**
1. The materials used in the production of the tea bag are biodegradable and environmentally friendly.	3.70	Highly Acceptable
2. The manufacturing process of the tea bag minimizes environmental impact, utilizing sustainable practices and resources.	3.60	Highly Acceptable
3. The tea bag helps reduce landfill waste by utilizing waste materials.	3.43	Highly Acceptable
4. The disposal of the tea bag does not contribute to environmental pollution.	3.47	Highly Acceptable
5. The tea bag overall promotes eco-friendly practices throughout its lifecycle, from production to disposal.	3.63	Highly Acceptable
GRAND MEAN	**3.57**	**Highly Acceptable**

Table 4.4 illustrates the acceptability of a biosorbent tea bag in terms of eco-friendliness. The statement that reveals that the materials of the tea bag are environmentally friendly and

biodegradable, had a highest computed weighted mean of 3.70, which is verbally interpreted as highly acceptable. On the other hand, the statement which states that the tea bag helps in reducing landfill waste through the utilization of waste materials has the lowest computed weighted mean of 3.43 and is verbally interpreted as highly acceptable. The overall weighted mean for the acceptability of a biosorbent tea bag is 3.57, which was verbally interpreted as highly acceptable. To support this, Velenturf & Purnell (2021) emphasized the urgency to shift away from its self-centered approach and linear economic model, which heavily relies on the continuous consumption of non-renewable resources, which leads to environmental concerns. Consequently, the utilization of biosorbent powder, crafted from organic materials, emerges as a promising solution to counteract these challenges. Furthermore, the biosorbent tea bag stands out from its counterparts by abstaining from chemical activators, instead opting for eggshells and dried leaves, which have notable ion exchange capabilities as a sustainable alternative, which also further proves the eco-friendliness of the product.

Table 4.5

Cost-effectiveness of Biosorbent Tea Bag

Acceptability of the Biosorbent Tea Bag		
Indicator - Cost-effectiveness	**Weighted Mean**	**Verbal Interpretation**
1. The tea bag offers a cost-effective solution for adsorbing heavy metal, metal, or metalloid ions in water.	3.00	Acceptable
2. The low-cost materials used in the production of the tea bag contribute to its affordability without compromising effectiveness.	3.37	Highly Acceptable
3. The tea bag provides a more budget-friendly solution for communities with limited financial resources.	3.33	Highly Acceptable
4. The cost-effectiveness of the tea bag is evident in its long-lasting performance, requiring fewer replacements and minimizing operational costs over time.	3.17	Acceptable
5. The affordability of the tea bag makes it accessible to a diverse range of users.	3.33	Highly Acceptable

GRAND MEAN	**3.24**	**Acceptable**

Table 4.5 signifies the acceptability of biosorbent tea bags in terms of cost-effectiveness. The statement indicates the cost-effectivity of the biosorbent tea bag in terms of the materials used and affordability of the product, revealing the highest computed weighted mean of 3.37, which is verbally interpreted as highly acceptable. On the contrary, the offer of the tea bag to provide a solution to adsorbing heavy metals, metal, and metalloid ions in water ranked lowest in the computed weighted mean which has 3.00 and was verbally interpreted as acceptable. To support this, previous research by Yaashikaa et al. (2021) has shown that the cost of commercial biosorbent material is typically lower compared to the cost of activated carbon and ion-exchange resins. This indicates that the use of biosorbent tea bags offers a cost-effective solution for water treatment, aligning with the findings indicating high acceptability in terms of cost-effectiveness.

Table 5.

Overall Acceptability of the Biosorbent Tea Bag

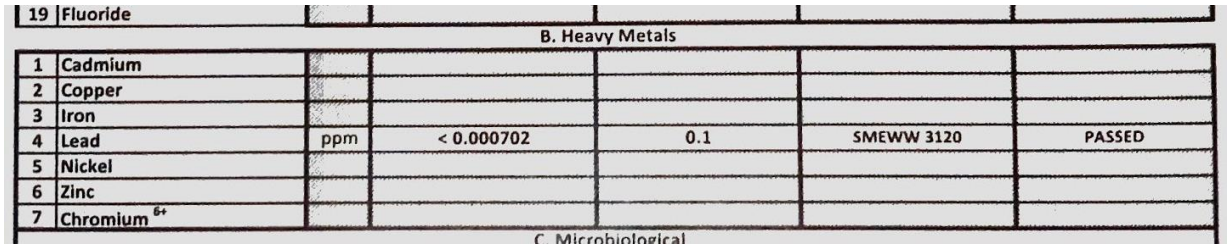
GENERAL CHARACTERISTICS	**Total Weighted Mean**	**Verbal Interpretation**
1. Acceptability of the *appearance* of the product	3.48	Highly Acceptable
2. Acceptability of the *odor* of the product	3.45	Highly Acceptable
3. Acceptability of the *storage life* of the product	3.39	Highly Acceptable
4. Acceptability of the *eco-friendliness* of the product	3.57	Highly Acceptable
5. Acceptability of the *cost-effectiveness* of the product	3.24	Acceptable
GRAND MEAN	**3.43**	**Highly Acceptable**

Table 5 shows the overall acceptability of the biosorbent tea bag. Based on the results, the biosorbent tea bag had a total mean of 3.43, indicating that the fire extinguisher is highly acceptable in terms of its characteristics.

Figure 3.1

Water Quality Analysis Results

Lead (Without Adsorbent)

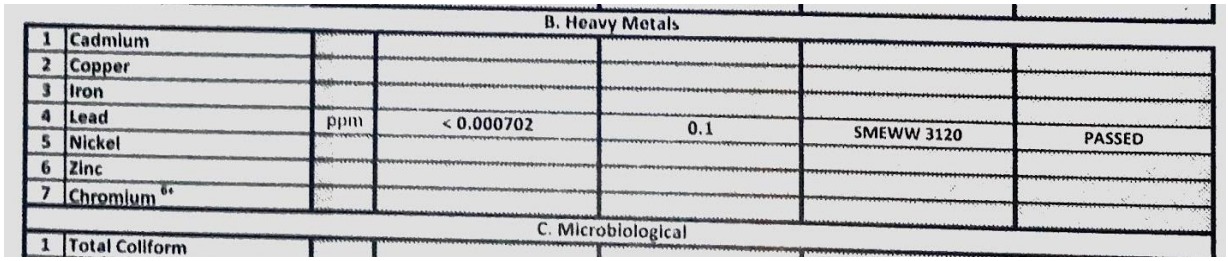


19	Fluoride					
	B. Heavy Metals					
1	Cadmium					
2	Copper					
3	Iron					
4	Lead	ppm	< 0.000702	0.1	SMEWW 3120	PASSED
5	Nickel					
6	Zinc					
7	Chromium $^{6+}$					
	C. Microbiological					

Figure 3.2

Water Quality Analysis Results

Lead (With Adsorbent)

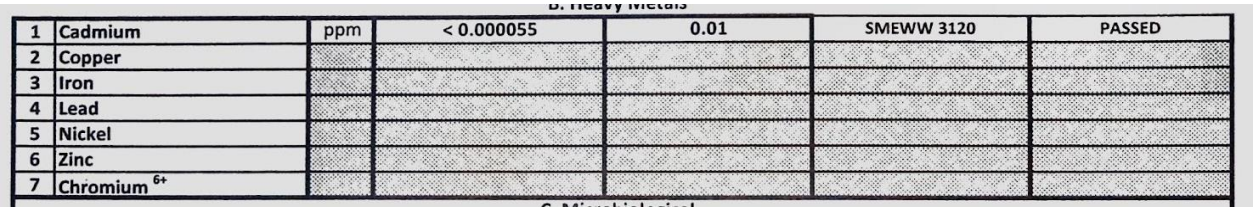


	B. Heavy Metals					
1	Cadmium					
2	Copper					
3	Iron					
4	Lead	ppm	< 0.000702	0.1	SMEWW 3120	PASSED
5	Nickel					
6	Zinc					
7	Chromium $^{6+}$					
	C. Microbiological					
1	Total Coliform					

Figure 4 .1

Water Quality Analysis Results

Cadmium (Without Adsorbent)

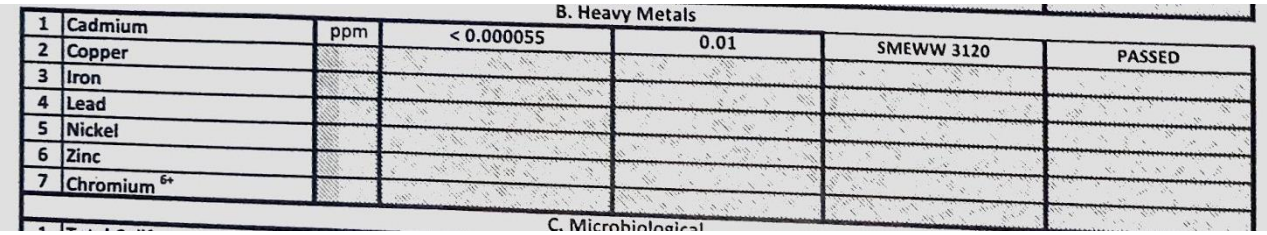


	B. Heavy Metals					
1	Cadmium	ppm	< 0.000055	0.01	SMEWW 3120	PASSED
2	Copper					
3	Iron					
4	Lead					
5	Nickel					
6	Zinc					
7	Chromium $^{6+}$					

Figure 4.2

Water Quality Analysis Results

Cadmium (With Adsorbent)



B. Heavy Metals

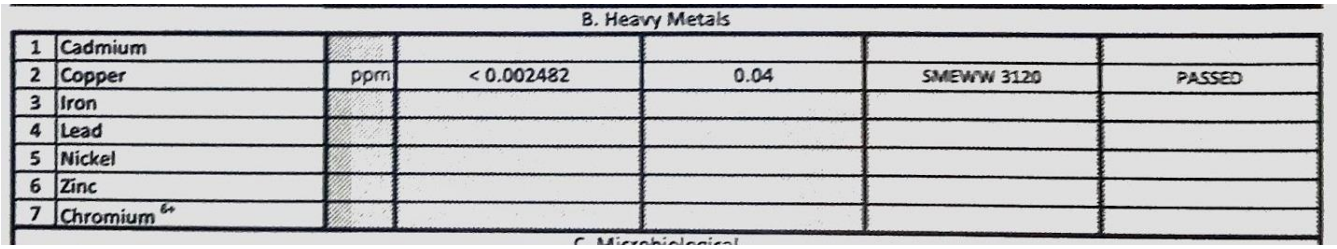
1	Cadmium	ppm	< 0.000055	0.01	SMEWW 3120	PASSED
2	Copper					
3	Iron					
4	Lead					
5	Nickel					
6	Zinc					
7	Chromium $^{6+}$					

C. Microbiological

Figure 5.1

Water Quality Analysis Results

Copper (Without Adsorbent)



B. Heavy Metals

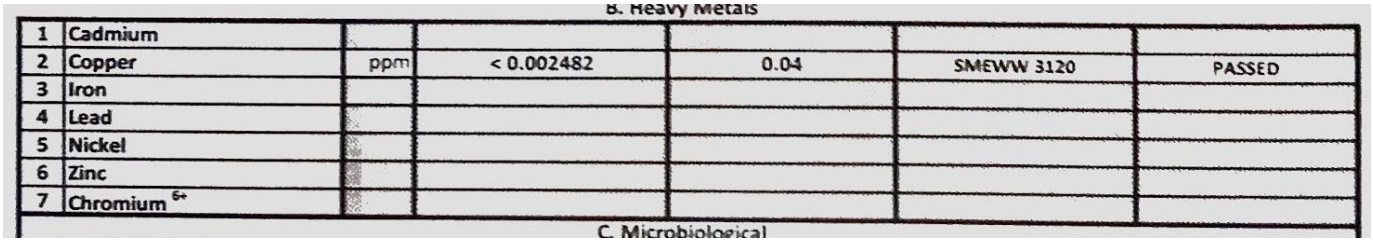
1	Cadmium					
2	Copper	ppm	< 0.002482	0.04	SMEWW 3120	PASSED
3	Iron					
4	Lead					
5	Nickel					
6	Zinc					
7	Chromium $^{6+}$					

C. Microbiological

Figure 5.2

Water Quality Analysis Results

Copper (With Adsorbent)



B. Heavy Metals

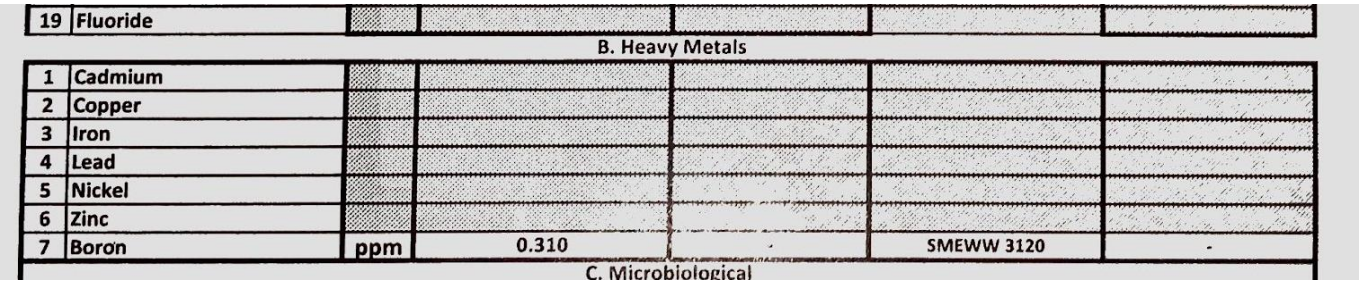
1	Cadmium					
2	Copper	ppm	< 0.002482	0.04	SMEWW 3120	PASSED
3	Iron					
4	Lead					
5	Nickel					
6	Zinc					
7	Chromium $^{6+}$					

C. Microbiological

Figure 6.1

Water Quality Analysis Results

Boron (Without Adsorbent)



19	Fluoride					
	B. Heavy Metals					
1	Cadmium					
2	Copper					
3	Iron					
4	Lead					
5	Nickel					
6	Zinc					
7	Boron	ppm	0.310	-	SMEWW 3120	-
	C. Microbiological					

Figure 6.2

Water Quality Analysis Results

Boron (With Adsorbent)

	B. Heavy Metals					
1	Cadmium					
2	Copper					
3	Iron					
4	Lead					
5	Nickel					
6	Zinc					
7	Boron	ppm	0.296	-	SMEWW 3120	-
	C. Microbiological					

V. Discussion

The data gathered revealed that the respondents possess a positive outlook to the product of the study. Overall, the results show the effectiveness of the biosorbent tea bag to adsorb metallic element ions, particularly the metalloid Boron (B), in water with a 2.76 total weighted mean, which can be interpreted as effective. Moreover, the results also show that the appearance of the tea bag is highly acceptable with a total weighted mean of 3.48; the odor is also highly acceptable with a total weighted mean of 3.45; the storage life with a total weighted mean of 3.39 which can be also interpreted as highly acceptable; the eco-friendliness is highly acceptable as well with a total weighted mean of 3.57. The cost-effectiveness of the product is also interpreted as acceptable having a total weighted mean of 3.24. Garnering a total weighted mean of 3.26 overall based on

each indicator, the researchers achieved a highly effective and highly acceptable result. Hence, the biosorbent tea bag made up of eggshells, dried banana leaves and dried guava leaves was proven to effectively adsorb metallic element ions in water, particularly Boron (B). To support this, according to Poonam et al. (2020), among biological methods, biosorption is one of the promising technologies for pollutant elimination because of its effectiveness, simplicity, and easy biomass availability. In addition to that, knowing that the biosorbent tea bag utilizes natural materials like leaves and biological waste materials like eggshells, while can also perform metal ion adsorption, it can possibly help the community, water facility professionals, as well as future researchers.

Although initially aimed to examine all heavy metals present in the water sample, due to financial and time constraints, only three heavy metals [Lead (Pb), Cadmium (Cd), and Copper (Cu)] were tested. However, the results of the water testing showed minimal to no changes after using the product, almost indicating ineffectiveness of the product, primarily due to the low concentration of heavy metals in the water samples, which the ICP-OES could not accurately measure. Furthermore, the scope of the study expanded to include other metallic elements, including metals and metalloids, with Boron (B) being one of them. The findings of this study are restricted to the elements tested and the source and volume of the sampled water. The effectiveness of the biosorbent tea bag was hindered by its design, which is originally designed for smaller volumes of water due to its size constraints. The tea bag used in the samples submitted for testing was insufficient to effectively treat larger volumes of water, thus impacting the scope of the study. It is important to note that the decision to test the tea bag containing 7 grams of the adsorbent mixture in 1000mL of water, although evidently insufficient, was made in accordance with the protocol of the testing laboratory in submitting a sample.

Additionally, it is important to mention that the tea bag demonstrated effectiveness solely in the adsorption of Boron, as it was the sole element the researchers were able to test to contain a higher concentration in the water samples submitted. The treatment efficiencies were recorded at 9.35% in the initial trial, 4.54% in the second trial, and 1.94% in the third trial, with a reported mean treatment efficiency of 4.52%. The concentration of boron in the water was found to effectively decrease in the sampled water with the adsorbent. Initially recorded at 0.321 in the pre-treatment stage, it reduced to 0.291 after treatment in the first trial, indicating a significant reduction in boron concentration. Moreover, the effectiveness of the biosorbent tea bag is evident when higher concentrations of certain elements are present in the water sample. The identification

of significant results relies on the findings obtained from the sample analysis. It should be also noted that this study only examined the effectiveness of a biosorbent tea bag in heavy metal, metal, or metalloid adsorption, and observed characteristics such as appearance, odor, storage life, eco-friendliness, and cost-effectiveness. Furthermore, as previously mentioned, the biosorbent tea bag should ideally be employed in smaller volumes of heavily contaminated water containing high concentrations of heavy metals, metals, or metalloids to accurately gauge its effectiveness in adsorption.

The researchers recommend using or adding other natural or waste materials that also possess good adsorption and ion exchange properties to enhance adsorption effects and effectively reduce waste materials while helping combat water contamination issues. Additionally, the researchers suggest further investigation into more heavily contaminated water sources and expanding the parameters of testing to include various types of water sources. This will provide a more comprehensive understanding of the effectiveness of biosorbents in real-world applications. Finally, the researchers recommend that future researchers further explore innovative techniques for purifying or distillation of treated water to make it potable, such as incorporating additional filtration steps or disinfection processes.

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Fire Prevention: The Effectiveness of Taro Plant Extract as a Fire Retardant Substance

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I. Abstract

Fire-related incidents have proven to be among the most destructive in recent years, inflicting devastation upon affected families. Such incidents result in property damage, injuries, and, tragically, loss of life. This study aims to investigate the effectiveness of taro plant extract as a natural fire retardant. Employing a Quasi-Experimental Research Design: the researchers utilized the Purposive Sampling Technique to select survey respondents. The researchers gathered data on its effectiveness using validated survey questionnaires, and it was analyzed and interpreted using mean scores. The researchers formulated a fire-retardant substance comprising taro plant extract, Aloe vera, talcum powder, and potassium alum. The results revealed that the prototype had highly effective outcomes across indicators such as appearance, odor, and substance efficiency in wood. The researchers demonstrated an experiment on the ability of the fire-retardant substances to create a protective char barrier, effectively inhibiting ignition and fire spread on wood. However, the researchers could not test the substance on materials like clothes, plastic, and cardboard due to the lengthy tannin extraction process. Despite promising results, further investigation into the fire retardant's long-term effectiveness on wood, exploration of faster tannic acid extraction methods, and improvement of consistency for a paint-like texture is recommended. Additionally, trials on larger materials like furniture to assess effectiveness against bigger fires are recommended to know the right ratio of the prototype for different sizes of flammable materials in Philippine households.

Keywords: *taro plant extract, tannic acid, fire retardant, taro, Aloe vera*

II. Introduction

Fire-related incidents are one of the most damaging incidents in the past few years, it causes devastation to the families that are being affected by this kind of situation. Fire leads to damage to property, injuries and the worst-case scenario is death. Most of these incidents are likely to happen in residential areas. According to Guzman (2023), the increase of fire Injuries in Quezon City last year was also higher at 402, compared to only 352 in 2022. Meanwhile, the property damages also increased by 834 percent last year with the number of damages of P15, 122, 588, 314, compared to P1, 619, 206, and 831 in 2022. This data shows that fire incidents caused devastation in Quezon City. Usually, fire starts in the materials that are easy to succumb to by flame; this can lead to large devastation to the community. Therefore, taro extract can prevent this start of fire. As these cases are continuously increasing, According to Visda (2018), taro extract coating can prevent the start of the fire in the materials that are being coated by taro extract because it has a substance called "tannin" which is fireproofing. However, Tannic acids are prone to mold growth when stored. Sherrell (2023) noted that Alum is bactericidal, meaning it prevents the growth of bacteria and fungi, which can cause mold.

Fire may cause a huge deal of destruction as well as great sorrow. It can scorch appliances, ruin possessions, and leave you with furniture that has been harmed by fire. Restoring something to its original state after severe burning is practically impossible. The intensity of the fire that started it determines how much damage it causes. Losses will be significant if the fire was started by a gas leak or short circuit, as it can spread quickly. As stated by Global Enterprise Disaster Restoration (2024), naturally, different fire restoration techniques are needed for different kinds of damage, it is also stated that it is evident that the cost of fire cleanup is higher for a property that has been destroyed by fire, including damaged concrete and furniture. However, a fire's aftermath can be disastrous, regardless of its origin. As stated by Guzman (2023), according to reports, the National Capital Region (NCR) has 2,008 fire events happening in residential areas, 213 in mercantile districts, and 132 in industrial sectors. Of the recorded fires, about 2,626 were deemed to be accidents alone; 64 were deliberate; 53 were natural; 31 were not stated; 20 were the result of negligence; and 1,757 are still being looked into. The burning of synthetic materials at home can quickly become poisonous. Moreover, according to Dong et al. (2021), traditional brominated flame retardants (BFRs) have adverse effects on both the environment and human health,

particularly impacting the sensitive developing nervous system. Given the similar physicochemical characteristics between novel brominated flame retardants (NBFRs) and BFRs, increasing evidence suggests the neurotoxic effects of NBFRs. Also, as stated by the study of Barón et al. (2015) and the study of Gan et al. (2016), there is a growing body of evidence indicating that NBFRs can have neurotoxic effects and potentially penetrate the blood-brain barrier (BBB), accumulating in brain tissue, which may adversely affect the nervous system.

Furthermore, according to Kurata et al., (2023), a fire disaster is considered a severe disaster that results in great life and financial losses. The researchers have created a varnish or coating using taro extract as a fire retardant substance that can be used to prevent fires. The purpose of this study is to examine the level of effectiveness of the said extract in resisting fire. Additionally, it aims to study the resistance and efficiency of fireproof extract and how long it will work. The researchers also aim to know how efficiently the fire retardant substance works in terms of different materials such as wood, cloth, and cartons. Therefore, the taro extract can prevent the fire from spreading as it contains a substance called tannin that can be used for fireproofing. The results of this study may help contain fires by preventing them from spreading to other materials in a home.

This study aims to answer the following questions:

1. **What was the level of effectiveness of the taro extract as a fireproofing substance?**
2. **To produce the fire-retardant substance, how much talcum powder, water, alum, Aloe vera, pigment, and taro plant are needed?**
3. **What were the characteristics that could be observed in the fire retardant substance in terms of:**
    - **3.1 Appearance**
    - **3.2 Odor**
4. **What was the level of the acceptability of the fire retardant substance work in terms of wood?**

The scope of the study focuses on evaluating the effectiveness of taro extract tannic acid as a fire retardant and efficacy. Additionally, the researchers sought to investigate whether the substance mixture could withstand different classes of fires, namely Class A fires involving

organic solids such as paper, commonly referred to as regular fires, Class B fires fueled by liquids and gasses, and Class K fires, particularly those originating from cooking oils. Given the prevalence of these types of fires in residential settings and their potential for significant damage, like in the firewood piles that can be a rapid source of spot fire ignitions and can easily spread fire to nearby structures in less than 30 seconds, a small flame can turn into a major fire.

Furthermore, large flames from the woodpiles are observed for all types and configurations of wood, and there is rapid fire growth on them. For these reasons, this study aims to provide valuable insights into the potential efficacy of taro extract tannic acid as a fire retardant across various fire classes. The naturally damaging reaction of wood to heat can be slowed down by applying an intumescent coat, and by doing so, the wood's protection can be further extended. Thus, this study will test the coating layers of tannic acid mixes as a fire retardant.

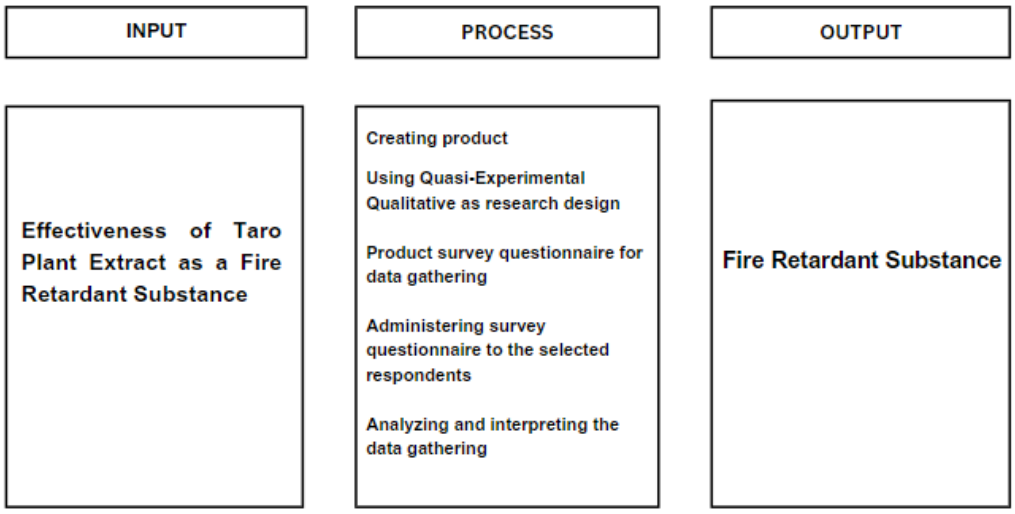
Moreover, this study will help homeowners, since it is beneficial for them to have fire retardant coating for their furniture to avoid major damage during fire accidents and also for them to gain knowledge that taro plants can be useful in making fire retardant substances. Additionally, it can also help the Bureau of Fire Protection to prevent the fire from spreading quickly. Additionally, the LGUs might support us by introducing our research to home factory outlets and one of the DILGs connected agencies (BFP). Lastly, future researchers can expand and improve the study.

This is anchored by the Coating Theory 1958 by F. L. Browne. This theory states that the combustion of products from wood and access of oxygen to the wood can be prevented by treatment with chemicals that melt and coat the wood fibers. According to Laura Anne Lowden & Terence Richard Hull (2013), the Coating theory provides a "Blanket" to protect the wood from burning and prevent the escape of the important component of fire which is Oxygen. Thermally active fire retardants can function in three ways: they can insulate the wood from the surrounding heat, absorb it through endothermic processes, or raise the thermal conductivity of the wood to dissipate the heat from its surface (Lowden et al., 2013). Their research is relevant since it shows how surface and coating technologies are used to avoid fires and ensure the durability employed by the researcher for this study, the chemicals utilized for fireproofing, and the thickness of the coating applied to the wood matrix to demonstrate fire resistance. The researchers will use tannin extracted from taro plants through various methods as fire retardant. The theory has guided the researchers to develop a Colocasia Esculenta (taro) extract as a coating applied to wood and other

materials that will meet the fireproofing substance. Additionally, the theory provides an understanding of the wood undergoes when heated and what coating can do as a providing protection when exposed to fire or heat. Finally, the idea mentioned helps the researchers to take a holistic view of the effectiveness of the Colocasia Esculenta (taro) leaves extracts as cheap and eco-friendly coating to reduce the firepower of widespread cases caused by fires in hostile environments.

Figure 1.

Conceptual Paradigm



The researchers utilized the Input, Process, and Output Model (IPO Model) presented in Figure 1.1 as the conceptual research model. This showed the effectiveness of Taro plant extract as a fire retardant substance as the input of the research and demonstrated the starting process of making the fire retardant substance as the product until the analysis and interpretation of the data collected. In addition, this model represents the output of this research — the fire retardant substance.

III. Methodology

The researchers used a Quasi-Experimental for conducting this research. According to Cook (2015), Quasi-experiments typically assess the causal effects of enduring treatments in real-world settings rather than controlled laboratory environments. However, unlike "true" experiments where treatment allocation is randomized, quasi-experiments rely on self-selection or administrator discretion for assignment. Therefore, the researchers used quasi-experimental to determine the effectiveness of the taro plant substance as an organic fire retardant coating for different materials.

On the other hand, a Purposive Sampling Technique is employed by the researchers in this investigation. This method is not random and doesn't require an underlying theory or a minimum number of participants. As stated by Etikan (2016) the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by knowledge or experience. Therefore, the researchers created criteria that the respondents needed to meet using the purposive sampling technique. The first set of respondents must be (1) a professional fire marshal, (2) is currently working, and (3) willing to participate. The second set of respondents must be (1) a homeowner who is currently living in a neighboring house, (2) owns materials that are prone to fire incidents like Liquefied Petroleum Gas (LPG), and lastly, (3) willing to participate. Finally, the third set of respondents are science teachers.

The researchers preferred the officers of the Bureau of Fire Protection Tagaytay to help them examine the use of the substance in each material against fire. The officers of the said institution will be the respondents of the study since they know the classification and effectiveness of the fire retardant substance in every material. In addition, they can also add recommendations and suggestions to improve the output of this study.

Product Trial Testing

	Raw Material	Amount	Procedure	Result
Trial #1	-Taro Plant - Water	500 grams 500 grams	Boil the taro plant for 1 hour and 30 minutes, and then filter the leaves and stem until only the substance is left. After filtering, boil it again for 30 minutes after straining to remove any remaining water and extract the tannic acid. After that when tannic acid is extracted, use it for coating. And then let the coated material dry.	The fire retardant became instantly effective. However, it has an unpleasant odor, and the substance easily molds after 3 days.
Trial #2	-Taro Plant -Water -Alum	1000 grams 3000 grams 100 grams	Boil the taro plant for 1 hour and 30 minutes, and then filter the leaves and stem until only the substance is left. After filtering, boil it again for 30 minutes after straining to remove any remaining water and extract the tannic acid. After that when tannic acid is extracted, cool it down then mix the alum to the substance until it is completely dissolved. Lastly, use it for coating. And then let the coated material dry.	Alum has no negative impact on the efficacy of substances. Rather, it lessens the unpleasant odor and extends the substance's shell life.
Trial #3	-Taro Plant -Water -Alum -Talcum Powder	1000 grams 3000 grams 100 grams 200 grams	Boil the taro plant for 1 hour and 30 minutes, and then filter the leaves and stem until only the substance is left. After filtering, boil it again for 30 minutes after straining to remove any remaining water and extract the tannic acid. After that	The consistency of the substance became a little viscous making it more suitable for coating. However it goes back to being fluid after an hour. Moreover, Aloe vera increases the

	- Aloe vera -Dye	500 grams 50 grams	when tannic acid is extracted, cool it down then mix the alum to the substance until it is completely dissolved. Lastly, use it for coating. And then let the coated material dry.	substance's fire retardant efficacy and shortens the time it takes for the coated material to darken and have a char-like appearance. Aside from that, the talcum provides a protective layer that increases the coverage and weather resistance of the products.

Taro Plant Extract as Fire Retardant Substance Performance

Activity	Duration before the wood creates combustion	Type of wood	Number of layers
Testing on Class A fire	1 minute and 44 seconds	Plywood	20
Testing on Class B fire	2 minutes and 55 seconds	Plywood	20
Testing on Class K fire	2 minutes and 3 seconds	Plywood	20

The researchers opted to utilize tannin derived from taro leaves as a fire-retardant substance. First, the researchers procured taro leaves and proceeded to segment them into smaller fragments. Second, they introduced 3 liters of water into a pot along with 1 kilo of the segmented taro leaves, allowing the mixture to simmer until a portion of the water evaporated. Following this, the leaves were extracted for 1 hour and 30 minutes to obtain the liquid essence. Post-extraction, the obtained liquid was transferred to another vessel and boiled for an additional 20 minutes. After that, the substance was filtered to isolate the tannin. Moving to the sixth procedure, 5 sachets of alum are added as preservatives to maintain the substance without getting mold. After the said procedure, the resultant substance was transferred into a container and then mixed with Aloe vera

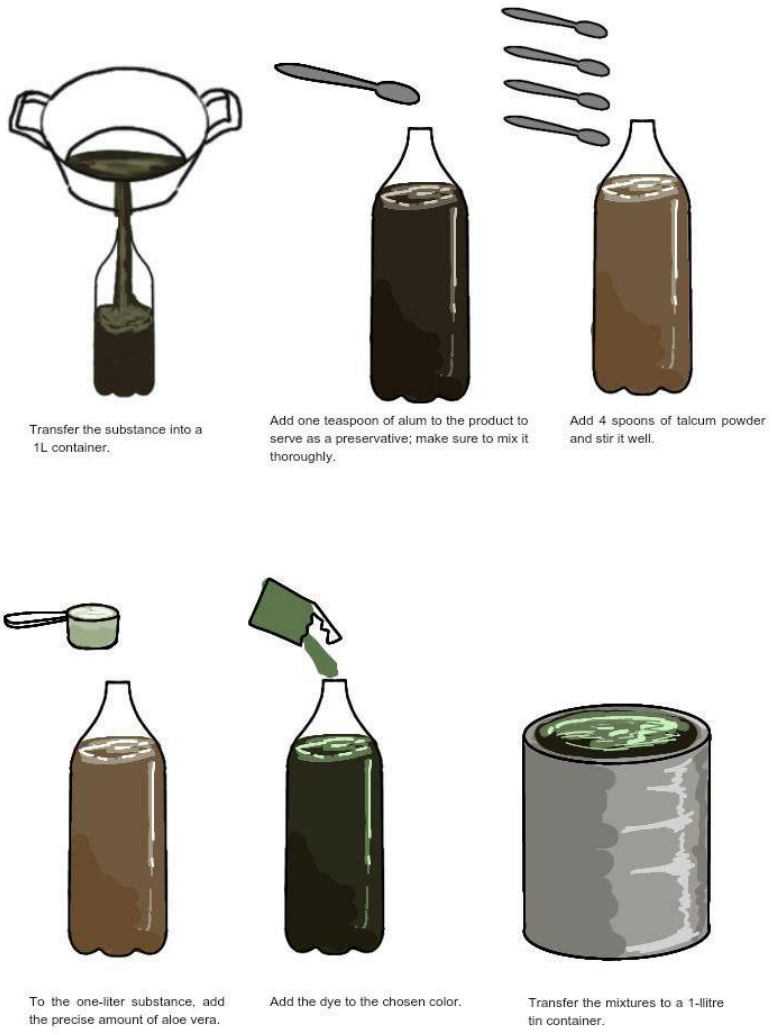
extract and talcum powder for consistency and to avoid abrasion. The dye will be added to create a presentable color to the substance. Finally, the substance will be mixed well until all the components are combined, thus completing the process of fabricating taro leaves into fire-retardant material.

Figure 2.

Experiment Procedure

Taro Extraction Procedure

Mixtures of Tannic Acid, Aloe vera, Talcum, and preservatives (Alum)



These steps are illustrated below (Figure 2) for a clearer understanding of the procedure.

Before conducting a survey to collect data, the researchers seek permission from the principal. After requesting permission, the approval is sent to the selected participants who met the study's criteria, which are Tagaytay officers from the Bureau of Fire Protection. The researchers collected the data for the research study using a survey questionnaire. This method aids in determining the effectiveness of the taro plant extract as a fire retardant substance. Furthermore, the survey includes an option for respondents to respond as well as a closed-end questionnaire that will assist researchers in evaluating their views and insights.

The statistical treatment that is utilized by the researcher is the weighted mean. Wherein, the mean is used to establish the respondents' verbal interpretation of each sentence and the mean score range was employed to arrive at a definitive result:

Acceptability of taro plant extract as fire retardant substance

Scale Ranges	**Qualitative Description**
3.26 – 4.00	Highly Acceptable
2.51 - 3.25	Acceptable
1.76 - 2.50	Slightly Acceptable
1.00 - 1.75	Unacceptable

Effectivity of taro plant extract as fire retardant substance

Scale Ranges	**Qualitative Description**
3.26 – 4.00	Highly Effective
2.51 - 3.25	Effective
1.76 - 2.50	Slightly Effective
1.00 - 1.75	Not Effective

IV. Results

Problem 1. What is the level of effectiveness of the taro extract as a fireproofing substance?

Table 1.
Effectiveness of Taro Plant Extract

Indicators	Weighted Mean	Verbal Interpretation
1. The product can increase fire resistance of the materials coated.	3.60	Highly Effective
2. The product can remain effective even after being coated with another material.	3.50	Highly Effective
3. It can withstand Class A type of fire (Ordinary Combustible) such as wood, paper cloth, etc.	3.57	Highly Effective
4. It can withstand Class B type of fire (Flammable Liquids) such as Grease, Oil, and solvents	3.63	Highly Effective
5. It can withstand K type of fire (kitchen-based fires) such as vegetable oils that are used in cooking operations	3.57	Highly Effective
Total Weighted Mean	**3.57**	**Highly Effective**

Table 1 presents the probability results of taro plant extract as a fire retardant substance. In the table, the highest weighted mean collected is 3.63, which states that it can withstand Class B type of fire (Flammable Liquids). In addition, the statement with the lowest weight mean collected is 3.5, which stated that the product can remain highly effective even after being coated with another material. Overall, the total amount of the weighted mean collected data is 3.57 which is verbally interpreted as highly effective. Moreover, the product can increase the fire resistance of the materials coated. To support this, according to a study by Silveira et al. (2019), tannins, ranked as the fourth most abundant renewable material sourced from plants, follow cellulose, hemicellulose, and lignin in prevalence. They are prevalent in various parts of plants, including

leaves, bark, wood, seed pods, and galls. As polyphenols, tannins exhibit noteworthy traits in forming char, a property highly desirable in flame retardant applications. Among polyphenols, tannins stand out for their exceptional ability to form char, making them particularly suitable for use in flame-retardant materials. This inherent char-forming capability renders tannins a valuable resource in enhancing fire resistance across diverse applications.

Problem 2. How much taro plant, talcum powder, alum, and Aloe vera are needed to make the fire retardant substance?

Table 1.
Components of the Fire Retardant Substance

Materials	Measurement
Taro Plant	1000 grams
Water	3 liters
Alum	100 grams
Talcum Powder	200 grams
Aloe vera	500 grams
Dye	50 grams

This indicates that to make the fire retardant substance, it needs 1000 grams of taro plant, 3 liters of water, 100 grams of alum, 200 grams of talcum powder, 500 grams of Aloe vera, and 50 grams of dye.

Problem 3. What are the characteristics that can be observed in the fire retardant substance in terms of:

3.1 Appearance

3.2 Odor

Table 2.
Appearance of the Fire Retardant Substance

Characteristics of Fire Retardant Substance		
Appearance - Indicators	**Weighted Mean**	**Verbal Interpretation**
1. The consistency of the substance is applicable for coating furniture.	3.73	Highly Acceptable
2. The consistency of the substance is applicable for coating furniture.	3.70	Highly Acceptable
3. The appearance of the product after exposure to fire is still relevant in a home setting.	3.47	Highly Acceptable
Total Weighted Mean	**3.63**	**Highly Acceptable**

Table 2 displayed the accessibility of the fire retardant substance's appearance based on the responses of the respondents. With the highest weighted mean of 3.73 shown in the tables, the statement implies that the appearance of the substance is suitable for coating furniture and that it is considered to be highly acceptable verbally. In addition, the weighted mean of 3.70 indicates that the product is usable in a home setting and has been rated as highly acceptable. The statement with the lowest weighted mean, on the other hand, received 3.47 and was rated as highly acceptable; this shows that the product's appearance after fire exposure is still relevant in the home setting. The total mean of the gathered data is 3.63, which is below the highly acceptable level. In conclusion, this could indicate that the resulting coating substance's appearance when applied to home furniture and after exposure to fire remains applicable. Mariappan (2016) highlights the significance of fire retardant coatings having attributes such as restricted flame spread, reduced smoke and toxic gas release, simple application, durable wear resistance, reliable adhesion, and economic viability. These coatings are available in two variations: transparent varnish and pigmented varnish, customized for particular materials and showcasing distinct responses to Intumescent coatings form a multicellular charred layer when subjected to heat, serving as insulation to impede heat and mass transfer between condensed and vapor phases.

Table 3.
The odor of the Fire Retardant Substance

Characteristics of Fire Retardant Substance		
Odor - Indicators	**Weighted Mean**	**Verbal Interpretation**
1. The odor of the substance is tolerable.	3.67	Highly Acceptable
2. The odor of the substance is tolerable during the coating process	3.67	Highly Acceptable
3. After the coating process, the odor of the material coated is tolerable.	3.77	Highly Acceptable
4. The odor of the material after exposure to fire is still tolerable.	3.60	Highly Acceptable
Total Weighted Mean	**3.68**	**Highly Acceptable**

Table 3 focuses on assessing the fragrance of a substance at different phases and in its coated state. The weighted mean of 3.67 in the table determines the substance's endurable odor, meaning that it is considered highly acceptable. Furthermore, the odor of the substance coated is tolerable both during and after coating, as indicated by the coating process 3.67 and weighted mean of 3.77 ratings, which regarded that the odor is highly acceptable. Additionally, the table indicated that the material's odor remained tolerable after being exposed to fire, with a mean of 3.60 indicating a highly acceptable odor. As a result, the total mean of the data collected is 3.68, which is highly acceptable. In this case, it was not expected to result in any major illness because it is known that the substance's odor is highly acceptable even after coating and after exposure to fire. To support this statement, Dalby (June 2020), tannic acid, in combination with sodium fluoride, reduces odor emissions, showing promise for a sustainable odor home setting. Therefore, knowing that the components of the fire retardant substance are not harmful and emit a bearable odor, means that the product's odor is acceptable for home application.

Problem 4. What was the level of the acceptability of the fire retardant substance work in terms of wood?

Table 4.
Substance Efficiency on Wood

Efficiency - Indicators	Weighted Mean	Verbal Interpretation
1. The number of layers of coating on the wood is suitable for home furniture. (20 layers)	3.57	Highly Accepted
2. The substance adheres well to the wood.	3.60	Highly Accepted
3. The substance is effective as a fire retardant when applied to wood.	3.73	Highly Accepted
Total Weighted Mean	**3.63**	**Highly Accepted**

Table 4 revealed the characteristics of fire retardant substances. The weighted mean of the number of coating layers (20 layers) deemed suitable for furniture was 3.57, which respondents found to be highly acceptable. The highest weighted mean 3.73, addresses the effectiveness of fire retardants applied to wood. Furthermore, the weighted mean of 3.60 effectively adheres the substance to the wood, yielding a highly acceptable outcome. Based on the data presented by the researchers, the total weighted mean of 3.63 indicates that the fire retardant ingredient is effective. According to a study by Fang-Fang Li (2023), tannic acid's quick conversion to carbon dioxide in the presence of fire makes it a suitable natural polyphenol for use in flame-retardant applications. Tannic acid releases non-flammable gasses such as carbon dioxide and phenylene triol when heated. Wood is a sustainable building material, exhibiting high endurance, low density, high strength, super toughness, and great malleability. As a traditional building material, ancient architecture is mostly built with wood. Under conditions of fire, woods carbonize and release flammable gasses, such as carbon monoxide, methane, and tar, to sustain the combustion process. Carbonized fibers of wood are easily split along textures, allowing for rapid transfer of mass and heat across the combustion interface.

V. Discussion

Fire incidents have proven to be the most disastrous for the past few years. This occurrence causes devastation to families, as this results in property damage and injuries to people. Taro plant extract can prevent this start of fire. Taro extract coating can reduce the fire intensity and delay the combustion of the coated material because it has a substance called “tannin”. The data acquired shows that the respondents have favorable opinions about the weighted mean for the fire retardant substance was 3.57 for effectiveness and 3.68 for acceptability of the characteristics. As a result, the researchers generated a successful outcome. Thus, the fire retardant material obtained from taro plants' tannic acid demonstrates that it is an effective coating material that keeps fires from starting on wood. To support this, Wang et al. (2022) stated that Tannic acid is a natural phenolic compound abundant in plants. It is beneficial in the flame retardant field due to its low combustion and good absorption characteristics.

The limitation of the study is that the tannic acid takes time to extract. It is also difficult to obtain a perfect amount of substance that is enough for coating wood, considering that 1 kilo of taro plant produces only 1 liter of substance. Furthermore, its consistency is too fluid for a coating substance. Hence, the researchers added Aloe vera which has a viscous consistency. Furthermore, Aloe vera is also an organic material that has fire-resistant properties. To support this, an analysis done by Haque et al. (2014) showed that Aloe vera leaves contain 1.90 mg/g of phosphorus. Moreover, due to its versatile fire-ceasing behavior, phosphorus is regarded as the most important element for developing environmentally friendly fire retardant systems. Due to limited time, the researchers also could not cover the experimental procedure on clothes, plastic materials, and other materials that can start fires.

Lastly, the researcher recommends testing the longevity of the effectiveness of the fire retardant substance when coated with wood. Since the substance was only tested on plywood, the researchers advise conducting additional trials to determine how long the coated wood takes to completely burn. Such as testing on larger materials like furniture to see if the substance is effective on larger fires. The researchers recommend finding a faster way of extracting tannic acid. Improving the consistency of the product into a paint-like texture can improve the substance to adhere well to different materials. Finally, the researchers recommend covering the experimental procedure on plastics, clothes, and other flammable materials that may start fire incidents

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Magnifying Glass and Thermoelectric Generator as an Alternative Solar Panel Device

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I. Abstract

The Philippines is facing an energy crisis, so the government promotes utilizing renewable energy like solar panel devices to achieve energy security. However, the traditional solar panel's material cost and installation hinder local Filipinos from availing even with the myriad benefits it could offer. The researchers created a product that amplifies solar energy using the Magnifying Glass and Thermoelectric Generator called the MGTEG Solar Panel Device as an Alternative to Traditional Solar Panels. This study used Quantitative Quasi-Experimental, and Purposive Sampling Technique to choose the respondents of the study. The data was collected through the use of survey questionnaires and analyzed the statistical data through mean scores. It was revealed that the MGTEG Solar Panel Device has both highly effective and highly acceptable results in terms of characteristics—portable, durable, and cost-efficient and conversion of heat into electricity, depending on the weather and heat index of the environment; as the researchers proved that the product works by powering different types of electronic devices using the stored electricity. Nevertheless, the researchers recommend more in-depth analysis and study about the device and how to maximize its usage not limited to utilizing solar energy, but also to other industrial devices that produce heat waste.

Keywords: *MGTEG Solar Panel Panel Device, Solar energy, Magnifying Glass, Thermoelectric Generator, Renewable Energy, Alternatives*

II. Introduction

The Philippines is facing an energy crisis, resulting in a widespread power shortage. To address this issue, the government is promoting renewable energy, energy efficiency, and emerging technologies to achieve energy security (International Trade Administration (IDA), 2024). Solar panels are one of the most promising investments in the country due to the relatively high temperatures, particularly during summer. It is also designed to withstand extreme weather making them appropriate as energy sources (Solar NRG Philippines, 2022). While solar energy has many benefits, the high initial costs of solar panel installation and the rare materials used in producing them make them expensive and challenging to afford for many Filipinos (De Guia, 2023). To solve this issue, the researchers created a practical solar panel device that was affordable for everyone and used readily available materials such as Magnifying Glasses (MG) that maximize the solar energy by concentrating the sunlight and directing the heat onto the aluminum sheet, and Thermoelectric Generators (TEG)—an electronic device that converts the heat into electricity. Hence, they thought of a product name, MGTEG Solar Panel Device. Moreover, they added a Car Battery for voltage storage, and an Inverter which converts Direct Current (DC) into Alternating Current (AC).

Solar panels are made of components, such as silicon solar cells that contain hazardous heavy metals and rare metals such as lead, cadmium, and lithium for solar batteries, thus, raising the cost (Aggarwal, 2024). Since solar cells employ rare materials that are notoriously expensive, the researchers utilized alternative materials such as MG, TEG, Car Battery, and Inverter. Solar Photovoltaic (PV) cells are the most important components of all solar panels; this is constructed of PV materials and electronics that employ the photoelectric effect to turn sunlight into electricity. However, the efficiency of the PV is determined by the amount of light absorbed from sunlight (Hudedmani et al., 2017). Thus, the researchers used MG on their product as the heat concentrator to maximize solar energy. On the other hand, MG could be dangerous when used as they could easily ignite fire (Gold, 2023). To avoid these hazards, the researchers utilized an aluminum sheet to receive the heat before passing it to the TEG. Solar panels last for about 30 years but as they get older, their efficiency also decreases due to their performance degradation. This caused an earlier replacement and resulted in an increase in solar panel junk in the landfill (Atasu et al., 2021). In

comparison, TEG has a long operational life, can perform a wide range of functions at high temperatures, and can be bulky, flexible, and portable devices (Jaziri et al., 2020).

The researchers created an alternative to solar panel devices by amplifying solar energy. They used MG, TEG, Car Battery, and Inverter as the main materials of the MGTEG Solar Panel Device. The materials used, especially the aluminum sheet, protected against fire and were relatively safe and less dangerous to users due to its property of quick transportation of heat away from the source (Bouvy, 2020). For additional electronic devices in the product, the researchers added an Indicator and a Switch along with the packaging and manuals to provide the users a knowledge of how to operate the MGTEG Solar Panel Device. The device was designed to generate renewable electricity for households and establishments. Therefore, this Quantitative Quasi-Experimental research aimed to develop a product that offers the benefits of the MGTEG Solar Panel Device in terms of portability, durability, affordability, and efficiency. Overall, the purpose of this study was to provide an alternative solution that promotes the usage of renewable energy and contributes to minimizing greenhouse gas emissions.

This study aimed to answer the following questions:

1. **How many Magnifying Glasses and Thermoelectric Generators will be needed for an Alternative Solar Panel Device to work?**
2. **What are the characteristics that can be observed in the Magnifying Glass and Thermoelectric Generator as an Alternative Solar Panel Device in terms of:**

    2.1 portability

    2.2 durability

    2.3 cost-effectiveness

3. **What is the level of effectiveness of Magnifying Glass and Thermoelectric Generator as an Alternative Solar Panel Device?**

The researchers aimed to develop an improved solar panel device by integrating MG, TEG, Car Battery, and Inverter. The scope included a thorough assessment of the product's portability, durability, affordability, and effectiveness. Tested its ability by using the device to power household electronic devices of the homeowners, Science Teachers, and Electricians in Cavite,

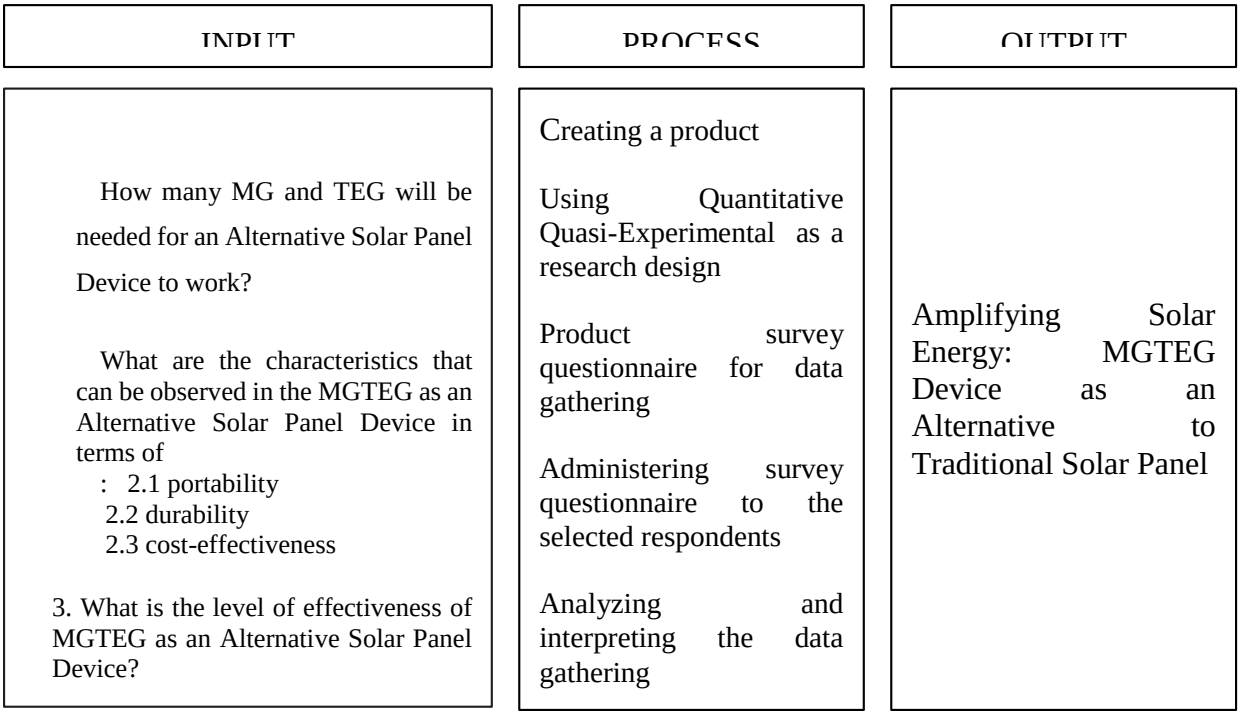
Philippines, and emphasized the promotion of prudent electric consumption. This study intended to serve as both a practical guide and a foundational resource for future innovations in renewable energy technologies.

This study was significant as it provided an affordable MGTEG Solar Panel Device. This benefits homeowners and establishments by potentially reducing electricity costs and promoting electric sustainability, electrician is one of the beneficiaries wherein they could develop the MGTEG into a better and enhanced solar panel device that could accommodate large industries. Upon the creation of this product, they had the advantage of having a portable, durable, and affordable MGTEG Solar Panel Device. Moreover, the students and teachers will know wise electric consumption and how the product would function. Lastly, for future researchers, this study served as a guide as they could expand and improve the existing knowledge in this specific field. This research serves as a foundation for future innovations in renewable energy that address environmental challenges linked to solar panel production.

This paper was supported by the Theory and Modeling of Materials for Renewable Energy by Guyer et al., (2021) wherein it was stated that renewable energy sources such as solar energy were attractive alternatives to fossil fuels because of their abundant supply and free to pollution power generation. In addition, the materials used for the production of solar panel devices needed a huge amount of silicon with the highest purity for it to effectively absorb the heat without being decomposed in the process. This theory strengthened the purpose of the researchers to innovate a solar panel device by using readily available materials which were the MG, TEG, Car Battery, and Inverter that guided them in achieving the product as effective in terms of amplifying solar energy into electricity.

Figure 1.

Conceptual Paradigm



The researchers applied the Input, Process, and Output Model (IPO Model) presented in Figure 1 as the conceptual research model. The first box consists of the statement of the problems and the materials used in creating the device. The process involved a Quantitative Quasi-Experimental approach that utilized a product survey questionnaire for data collection. This survey was administered to the selected respondents. The analysis and interpretation of the gathered data were focused on creating a solar panel with MG and TEG that served as key components. This resulted in the final output of the research, the Amplifying Solar Energy: MGTEG Device as an Alternative to Traditional Solar Panel.

III. Methodology

The researchers utilized a Quasi-Experimental in conducting this research. This involved numerical data collection and statistical analysis. It draws statistical conclusions from quantitative data that could enhance quasi-experimental research by revealing respondents' observations, and opinions regarding the product created by the researchers (Villegas, 2022). Hence, the researchers used this to determine the effectiveness of the MGTEG Solar Panel Device.

The researchers used the Purposive Sampling Technique wherein the respondents were chosen deliberately based on their fit to the goals of the study. Every step of the sampling procedure was dependent on the researcher's judgment and knowledge specific to the context (Obilor, 2023). Thus, with the use of the purposive sampling technique, the researchers made criteria that the respondents should meet: (1) Electricians, (2) Science Teachers with knowledge and background in science and technology fields, and lastly, (3) Homeowners.

The researchers had a maximum of 3 Electricians, 10 Science Teachers from Olivarez College Tagaytay, and 20 homeowners as respondents who helped them examine the effectiveness of the MGTEG Solar Panel Device. The initial respondents of the researchers were electricians since they were professionals and had knowledge when it came to developing, testing, and supervising the manufacture of electrical equipment. Moreover, they added recommendations and suggestions to the researchers to improve their study. They chose Science Teachers and Homeowners to determine the acceptability and effectiveness of the MGTEG Solar Panel Device. To clarify, the researchers had a total of 33 respondents in the study.

With the guidance of these studies, the researchers conducted trials and product testing that accomplished the effectiveness of the MGTEG Solar Panel Device:

Trials and Testing of the MGTEG Solar Panel Device

	Materials	Time Range	Battery Progress	Output of TEG	Weather
1st Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (3mm); Rubber Sheet; Insulation; Stainless Steel Sheet; Car Battery (12v/3Ah); Inverter; 2 Voltage Boosters	2:30 p.m. 3:00 p.m	9.19v 9.18v	0v 0v	Partially Cloudy
2nd Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (3mm); Rubber Sheet; Insulation; Stainless Steel Sheet; Car Battery (12v/3Ah); Inverter; 2 Voltage Boosters	9:30 a.m. 10:00 a.m. 10:30 a.m. 11:00 a.m. 11:30 a.m. 12:00 p.m.	N/A	0v 0.0027v 0.0069v 0.0125v 0.0045 0v	Sunny, Cloudy, and Partially Cloudy
3rd Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (1mm); Rubber Sheet; Insulation; Stainless Steel Sheet; Car Battery (12v/3Ah); Inverter; Diode (1000uNI); Capacitor (50v/1000uF)	9:30 a.m. 10:00 a.m. 10:30 a.m. 11:00 a.m. 11:30 a.m. 12:00 p.m. - 2:00 p.m. 2:30 p.m. 3:00 p.m. 3:30 p.m.	6.29v 6.29v 6.31v 6.32v 6.34v 6.35v - 6.38v 6.41v 6.42v 6.44v	N/A	Sunny
4th Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (1mm); Rubber Sheet; Insulation; Stainless Steel Sheet; Car Battery (12v/3Ah); Inverter; Diode (1000uNI); Capacitor (25v/1000uF)	12:00 p.m 12:30 p.m. 1:00 p.m. 1:30 p.m. 2:00 p.m. 2:30 p.m. 3:00 p.m. 3:30 p.m. 4:00 p.m. 4:30 p.m. 5:00 p.m.	4.65v 4.71v 5.30v 5.27v 5.46v 5.59v 5.64v 5.67v 5.68v 5.70v 5.70v	- - 4.77v 4.80v 5.46v 5.59v 5.64v - - - -	Sunny and Partially Cloudy

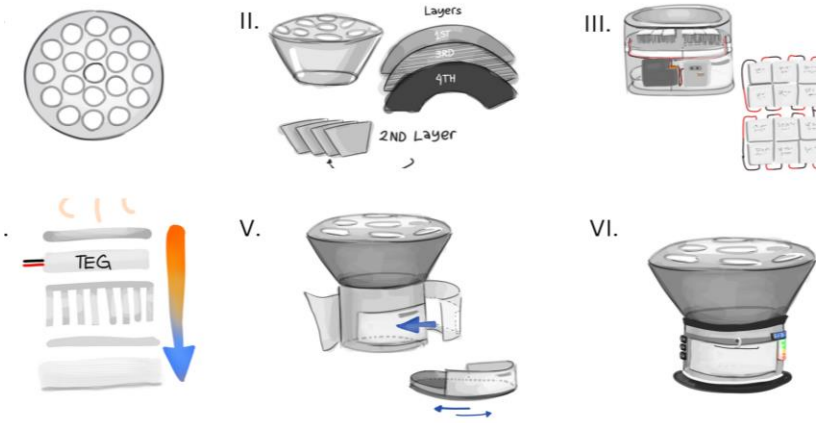
5th Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (1mm); Rubber Sheet; Stainless Steel; Insulation; Car Battery (12v/3Ah); Inverter; Diode (6A); Capacitor (25v/1000uF)	8:30 a.m. 9:30 a.m. 10:30 a.m. 11:30 a.m. 12:00 p.m. 12:30 p.m. 1:00 p.m. 1:30 p.m. 2:00 p.m.	5.44v 5.50v 5.53v 5.63v 5.70v 5.73v 5.74v 5.76v 5.76v	5.01v 5.15v 5.01v 5.63v 5.70v 5.73v 5.74v 5.76v 5.76v	Sunny, Cloudy, and Partially Cloudy
6th Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (1mm); Rubber Sheet; Stainless Steel; Insulation; Car Battery (12v/3Ah); Inverter; Diode (6A)	2:30 p.m. 3:00 p.m. 3:30 p.m. 3:45 p.m.	5.50v 5.72v 5.55v 5.67v	5.50v 5.72v 5.22v 5.11v	Sunny and Cloudy
7th Trial & Testing	19 MG; 12 TEG & Heatsinks; Aluminum Sheet (1mm); Rubber Sheet; Stainless Steel; Insulation; Car Battery (12v/3Ah); Inverter; Diode (6A)	8:00 a.m. 8:30 a.m. 9:00 a.m. 9:30 a.m. 10:00 a.m. 10:30 a.m. 11:00 a.m. 11:30 a.m. 12:00 p.m. 12:30 p.m. 1:00 p.m. 1:30 p.m. 2:00 p.m. 2:30 p.m. 3:00 p.m. 3:30 p.m 4:00 p.m. 4:30 p.m. 5:00 p.m.	5.80v 6.20v 6.29v 6.51v 7.21v 7.56v 7.65v 8.18v 8.20v 8.33v 8.87v 9.35v 9.44v 9.47v 9.83v 9.97v 10.18v 10.30v 10.40v	N/A	Sunny and Partially Cloudy

After all the trials and testing of the MGTEG Solar Panel Device, the researchers came up with the materials: 19 MG, 12 TEG, 12 Heatsinks, Aluminum Sheet (1mm), Stainless Steel Sheet, Insulation, Rubber Sheet, Car Battery (12v), Inverter, Diode (6A), Switch, and an Indicator. The first step in creating the MGTEG was the Heat Chamber. First, they cut a circular shape onto the

Stainless Steel and ground 19 holes that served as slots for the MG. Second, they cut four layers of cover: (1) Aluminum sheet that helped to trap the heat inside that passed to the main absorber, fragments of (2) Stainless Steel as an additional framework that secured the durability, (3) Insulation that trapped all the heat inside, and (4) Rubber Sheet, that ensured that the heat inside would not be passed outside—making the heat chamber manageable and safe to touch. Lastly, they cut a circular-shaped Aluminum Sheet that served as the main heat absorber and transporter to the TEG. The Energy Storage was the second step in creating the MGTEG Solar Panel Device. They cut two pieces of circular Stainless Steel Sheet, one for the base of the TEG and Heatsink (HS), and another one for the base of the drawer. Second, cut a rectangular shape of Stainless Steel Sheet; this covered the whole energy storage. Third, they attached two sets of TEG with HS—six each set—with a total of 12 TEG and HS and connected the wires to their opposite color. Fourth, they attached Insulation underneath the Stainless Steel that made sure that excess heat would not pass through the battery area and affect the electrical components inside. Fifth, they started to connect the Diode and a Switch to the same positive wire and connect it to the Car Battery together with the negative wire. They also attached a Switch to the Inverter and Indicator. Next, they cut a rectangular shape on the cover of the energy storage for the space of the drawer then put all the electronic components inside. Lastly, they cut a circular Insulation and attached it to the hollow part of the energy storage, then cut another circular shape on the Rubber Sheet and attached it beneath the whole product. This made sure that the MGTEG Solar Panel Device would not slip. Lastly, they attached all the Switches to the side of the drawer—the Indicator on the other side—for convenient use. The procedure of the MGTEG Solar Panel Device is illustrated in *Figure 2.*

Figure 2.

Experiment Procedure



In starting the survey proper, the researchers had the permission of the principal to survey the school premises. Next, the researchers sent informed consent to the chosen respondents who met the criteria set which were the Electricians, Science Teachers, and Homeowners. Their answers were gathered through the use of printed close-ended survey questionnaires and Google forms that had choices and were guided by the researchers. Using this type of data-gathering procedure helped the researchers to determine the level of effectiveness of amplifying solar energy through the use of the MGTEG solar panel device.

The statistical treatment that the researchers used was mean scores; wherein the mean established the verbal interpretation of the mean score range employed:

Scale Ranges	Qualitative Description
3.26 – 4.00	Highly Acceptable
2.51 - 3.25	Acceptable
1.76 - 2.50	Slightly Acceptable
1.00 - 1.75	Unacceptable

Scale Ranges	Qualitative Description
3.26 – 4.00	Highly Effective
2.51 - 3.25	Effective
1.76 - 2.50	Slightly Effective
1.00 - 1.75	Not Effective

IV. Results

Problem 1. How many Magnifying Glasses and Thermoelectric Generators will be needed for an Alternative Solar Panel Device to work?

Table 1.

Measurements of materials, purpose, quantity, and voltage production

Materials			
Non-Energy Producing Materials	**Quantity**	**Purpose**	**Measurements**
➔ Magnifying Glass	19 pcs	Heat Concentration	d = 7.5cm (75 mm)
➔ Aluminum Sheet	1 pc	Main Heat Absorber	d= 25cm (250 mm)
	1pc	Inner Layer of Heat Chamber	c^1= 131.88cm (1318.8mm) c^2= 78.5cm (785mm)
➔ Stainless Steel	1 pc	Framework	a= 2m×1m
➔ Insulation	1 pc	Protection Layer	a= 1m×1m
➔ Rubber Sheet	1 pc	Protection Layer	a= 1m×1m
	1pc	Outer Layer of Heat Chamber	c^1= 135cm (1350mm) c^2= 80cm (800mm)
➔ Voltmeter	1pc	Shows Stored Volts	
➔ Indicator	1pc	Shows the Battery Percentage based on LED lights.	h= 8cm (80mm)
● LED Lights	5pcs		d= 3mm
● Resistor	5pcs		l= 5mm
Switch	3pcs	Enable the users to charge the battery and use indicators conveniently.	h= 1.5cm (15mm) l= 1cm (10m)

Energy Producing Materials, Storage, & Pathway	Quantity	Purpose	Measurements
Thermoelectric Generator	12 pcs	Converts Heat into Electricity	1v ~ 12v DC
Diode	1pc	Directs Current to the Car Battery	N/A
Car Battery	1 pc	Energy Storage	V=12v DC
Inverter (DC to AC)	1 pc	Device to Use the Stored Energy	V= 12v DC -> 220v AC

Table 1 indicated that the MGTEG Solar Panel Device needed 19 MG and 12 TEG for it to work. The MG maximized the solar energy by concentrating the heat onto the heat chamber where the TEG converts the heat into electricity. Aside from MG and TEG, the researchers utilized an aluminum sheet as the main heat absorber and an inner layer of the heat chamber; stainless steel as the framework; and insulation and rubber sheet as a protection layer for both the users and the product itself. The stored energy in the Car Battery could be used using the Inverter. To be more convenient to the users, the researchers added an Indicator with five LED lights and five resistors—that showed the Battery Percentage based on LED lights, and a Switch.

Problem 2. What are the characteristics that can be observed in the Magnifying Glass and Thermoelectric Generator as an Alternative Solar Panel Device in terms of:

2.1 portability

2.2 durability

2.3 cost-effectiveness

Table 2.

Characteristics of the product based on portability, durability, and cost-effectiveness

Characteristics of the MGTEG Solar Panel Device		
Indicators	**Mean**	**Verbal Interpretation**
Portability	3.58	Highly Acceptable
Durability	3.64	Highly Acceptable
Cost-effectiveness	3.55	Highly Acceptable
Total Mean	**3.59**	**Highly Acceptable**

Table 2 shows the acceptability of the characteristics of the MGTEG Solar Panel Device based on the answers of the respondents. The statement with the highest mean computed of 3.64 in the table was the durability of the product and was verbally interpreted as highly acceptable. On the other hand, cost-effectiveness had the lowest computed mean of 3.55 and was verbally interpreted as highly acceptable. Overall, the characteristics of the MGTEG Solar Panel Device had a mean of 3.59 with a verbal interpretation of highly acceptable. The researchers ensured that all the materials used could perform a wide range of functions at high temperatures, and could be bulky, flexible, and portable devices, especially the TEG—that was the main material of this product (Jaziri et al., 2020)**.**

Table 2.1

Portability of the MGTEG Solar Panel Device

Characteristics of MGTEG Solar Panel Device		
Portability - Indicators	**Mean**	**Verbal Interpretation**
1. The MGTEG Solar Panel device can be easily moved.	3.85	Highly Acceptable
2. Using the MGTEG Solar Panel Device can be done through the guide of manuals.	3.52	Highly Acceptable
3. The MGTEG Solar Panel device can be activated without a complicated setup.	3.36	Highly Acceptable
Total Mean	**3.58**	**Highly Acceptable**

Table 2.1 conveyed the acceptability of portability on using the MGTEG Solar Panel Device. The statement with the highest mean of 3.85 in the table stated that the product could be easily moved. The lowest mean stated that the device could be activated without a complicated setup, with 3.36, and still verbally interpreted as highly acceptable. The overall mean of the portability of the MGTEG Solar Panel Device was 3.58, which was regarded as highly acceptable. Despite the weight of the electronic devices inside the product, they made sure that the MGTEG device could still offer the portability of it. The portable energy storage systems were a valuable tool that could be utilized in various settings. They were capable of powering in remote locations and providing critical backup power in case of an emergency (Emma, 2023).

Table 2.2

Durability of the MGTEG Solar Panel Device

Characteristics of MGTEG Solar Panel Device		
Durability - Indicators	**Mean**	**Verbal Interpretation**
1. MGTEG Solar Panel Device can be stored without its effectiveness deteriorating.	3.42	Highly Acceptable
2. The MGTEG Solar Panel Device can withstand high temperatures up to 100° C.	3.85	Highly Acceptable
3. The MGTEG Solar Panel Device is not easy to explode.	3.55	Highly Acceptable
4. The MGTEG Solar Panel Device can withstand strong winds.	3.79	Highly Acceptable
5. MGTEG Solar Panel Device is water resistant.	3.61	Highly Acceptable
Total Mean	**3.64**	**Highly Acceptable**

Table 2.2 exhibited the durability of the MGTEG Solar Panel Device following the submitted answers of the respondents. The second statement received the highest mean of 3.85 with a verbal interpretation of highly acceptable. Otherwise, the first statement got the lowest computed mean of 3.42, which was still highly acceptable. Generally, the total mean of the product's durability was 3.64, which implied that it was highly acceptable for the users. Due to the electrical components inside the device, the researchers ensured that it would not be affected by heat, water, or any harsh conditions from its surroundings. The importance of product durability became increasingly recognized as globalization strives to move towards a circular economy, where products are designed and manufactured in a way that helps save resources and minimize waste (Mesa et al., 2022).

Table 2.3

Cost-effectiveness of the MGTEG Solar Panel Device

Characteristics of MGTEG Solar Panel Device		
Cost-effectiveness - Indicators	**Mean**	**Verbal Interpretation**
1. The MGTEG Solar Panel Device is much more affordable than the original Solar Panel Device	3.55	Highly Acceptable
2. The cost of the installation of the MGTEG Solar Panel Device is acceptable.	3.55	Highly Acceptable
Total Mean	**3.55**	**Highly Acceptable**

Table 2.3 presents the cost-effectiveness of the MGTEG Solar Panel Device based on the gathered data. Both statements got the same mean score of 3.55 and were verbally interpreted as highly acceptable. Altogether, the total mean of the product's cost-effectiveness was 3.55 highly acceptable as its verbal interpretation. In this case, knowing that the alternative product was cost-effective meant that the number of Filipinos who own solar panels could multiply. This would also help any corporation and factories to save on costs such as labor and materials, while also providing their customers with quality products (Williams & Whiting, 2023).

Problem 3. What is the level of effectiveness of Magnifying Glass and Thermoelectric Generator as an Alternative Solar Panel Device?

Table 3.

Effectiveness of the MGTEG Solar Panel Device

Indicators	Mean	Verbal Interpretation
1. The MGTEG Solar Panel Device can produce high Direct Current (DC) and Alternative Current (AC) voltage.	3.61	Highly Effective
2. The MGTEG Solar Panel Device fills the battery within a three-day time frame.	3.42	Highly Effective
3. MGTEG Solar Panel Device can charge several electronic devices	3.64	Highly Effective
4. The MGTEG Solar Panel Device can work during daylight, depending on the weather:		
Sunny	3.85	Highly Effective
Cloudy	3.42	Highly Effective
Partially Cloudy	3.33	Highly Effective
Rainy	2.64	Effective
5. The MGTEG Solar Panel Device certainly can produce energy while being environmentally friendly.	3.76	Highly Effective
Total Mean	**3.46**	**Highly Effective**

Table 3. Corresponding to the answers of the respondents, the table showed the effectiveness of the MGTEG Solar Panel Device. The highest mean statement was the product's most effective work weather—Sunny—with 3.85 under highly effective verbal interpretation. On the contrary, the lowest statement that garnered 2.64 computed mean was under the effective work weather of the product—Rainy. With these results, it was shown in the data that the product could

still work and produce enough voltage to power different types of weather as long as the battery had been charged. The TEG utilized in some of the solar panels could still produce electricity even at night (Wilkins, 2022).

V. Discussion

Overall, to determine the effectiveness of Amplifying Solar Energy using the MGTEG Device as an alternative to traditional solar panels, the researchers concluded that the respondents had a positive outlook on the study and the product itself by the gathered data. The MGTEG Solar Panel Device garnered a total mean of 3.46 in terms of effectiveness, while the highest mean of 3.85 with high effectivity in verbal interpretation talked about the effectiveness of the product under sunny weather. The lowest mean was about the effectiveness, but this time under the rainy weather; it garnered a total mean of 2.64 with a verbal interpretation of effective. Concerning the acceptability of the product, the total mean was 3.69 with highly acceptable verbal interpretation. The highest computed mean of 3.71 was garnered by the durability and verbally interpreted as highly acceptable, while the lowest was the portability with a total of 3.68 and still verbally interpreted as highly acceptable. Both categories reached highly effective and highly acceptable results. Hence, the MGTEG Solar Panel Device proved to be effective in terms of amplifying solar energy through the use of MG and TEG where the nanostructured materials become economically feasible in utilization that has no moving parts, has a long lifetime, and is quiet in operation (Mamur et al., 2021). In line with this, the researchers achieved to create an alternative solar panel that was more affordable in terms of composition and installation.

To clarify, the number of TEG in the product could only produce one to 12v and still depends on the presence of the sun and the heat accumulated in the heat chamber. The inner layer of the heat chamber was composed of an aluminum sheet with a one-millimeter width. This material has similarities with copper but they also have differences when it comes to heat dispersion. Moreover, with only the car battery of 12v/3Ah capacitance, the MGTEG device could only power electrical appliances with 220v once the battery had 10-12v. Any lower volts than this would be restricted to power only the USB port. The researchers also discovered the significance of the design and durability of the product. The MG could be maximized when the focal point was

calculated corresponding to the height of the heat chamber. Aside from the product's limitations, the researchers also encountered difficulties in reading the data due to the instrumental unavailability such as the Multimeter Tester and Industrial Temperature Reader, knowledge about the TEG, and the timeframe of the whole experimental period.

Therefore, the researchers' recommendations—based on the lowest mean scores from the result—intends to provide a comprehensive guide for developing and optimizing the MGTEG Solar Panel Device. The researchers' recommends a critical choice of materials' quality especially for the main materials: MG, TEG, Car Battery, and Inverter. To make the MGTEG more affordable, choose one MG with outstanding light transmission, and is customized in measurement. With only one focal point, the future researchers would not have a hard time designing the heat chamber and would lessen the expenses from 19 MG of the original MGTEG. Additionally, for the energy storage, future researchers and developers could use a Printed Circuit Board (PCB) for a more understandable path of wires starting from the output of the TEG down to the outlet of Inverter, along with the product's manual explaining the compositions of the product, how to operate, and warnings of using the MGTEG. In this case, users would not have a hard time understanding the setup of the MGTEG. Lastly, comparative research with original solar panels could assist in determining the benefits, drawbacks, and potential for scalability of a global knowledge contribution in renewable energy applications focusing not only on amplifying solar energy but also on utilizing other industrial devices that emit heat wastes.

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Effective Strategies of Wet Market Vendors at Silang Market

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I. Abstract

Wet markets, known as palengke, are traditional food providers and agricultural product sellers' places. Despite selling similar products, they compete directly as businesses offering similar items. In today's food industry, the increasing number of wet market vendors indicates heightened competition, which can lead to lower profits. To sustain and advance their businesses, researchers aimed to explore effective business strategies of wet market vendors with direct competitors at Silang Market. The study utilized Cliff Bowman and David Faulkner's Bowman's Strategic Clock as a theoretical framework. A descriptive research design was employed, and thirty reliable respondents were selected through purposive sampling to answer a modified survey questionnaire. The researchers discovered that five strategies effectively address direct competition: Low price and Low Value-Added, Low Price, Hybrid, Differentiation, and Risky High Margins. Therefore, it is recommended that these strategies be implemented not only in wet markets but also in businesses facing direct competition. Emphasizing value, pricing, and product distinctiveness is crucial, with Differentiation identified as the most effective strategy based on the findings.

***Keywords**: Direct Competition, Low Price and Low-Value-Added, Low Price, Differentiation, Hybrid, Risky High Margin,*

II. Introduction

Wet markets offer a wide range of fresh meats and vegetables at affordable, often negotiable prices (Lindsay, 2020). In the Philippines, wet markets, commonly known as “palengke” among the Tagalogs, are considered traditional food providers and agricultural products and are popular retail outlets for household goods (Carmen, et al., 2023). However, competition is one of the most inevitable forces in today’s business world. It is a contest among businesses to attract customers and sales (Adom, et al., 2016). There are two types of business competition: direct and indirect, although this study solely focused on direct competition. As wet markets often sell nearly identical products, they compete directly with one another (Lemus-Aguilar, 2019); businesses provide your customers with a similar offering and a reasonable alternative to your product or service (Wiley, 2016).

In today's food industry, even though competition is a threat to a business, it is still evident that the number of wet market vendors has increased in recent years; therefore, direct competition exists between them (Lemus-Aguilar, 2019). Alarmingly, the higher the rival the business can get, the higher the possibility of lower profit (Abling et al., 2019), and as time went, it can be even tighter and may lead to bankruptcy (Umar et al., 2018). Hence, a strategy is crucial in facing the competitors. The business strategy represents an important part of the economy and encourages that sector to concentrate on marketing to expand its competitive edge (Abdulwase et al., 2020).

Considering the statement above, it is clear that direct competition is prevalent inside wet markets, even though it can affect businesses in terms of financial matters. To sustain and advance their ventures, the researchers delved into the various strategies that most wet market vendors employ, who sell fresh meat and have at least three years of practical experience running a small business at Silang Wet Market. With the help of Bowman's Strategic Clock, the researchers chose five strategies that the wet market vendors could use: Low price and Low value-added, Low price, Hybrid, Differentiation, and Risky high margin.

Recently, as the era of business competition inside the wet market has become tougher, business people must continuously find ways and strategies to overcome the issue, given that only those businesses that are geared with best practices and properly managed can survive (Farida & Setiawan, 2022; Domingo, 2018). This emerging issue among small businesses must be addressed, knowing direct competition might lead to business losses.

Wet markets perfectly represent Direct Competition, as they offer the same product, where varied fresh meat is sold (Thomas, 2020). The only thing that distinguishes them is the marketing mix strategies (Lemus-Aguilar et al., 2019). Thus, the researchers evaluated those vendors' approaches and assessed their efficacy in dealing with business rivalry.

This study determines the effective strategies of wet market vendors with direct competitors at Silang Market. Specifically, the study seeks to answer the following questions:

1. What is the demographic profile of wet market vendors at Silang Market in terms of:

1.1 Kind of product

1.2. Experience (years)

2. What are the effective business strategies utilized by wet market vendors at Silang, Cavite?

2.1 Low Price Value-Added

2.2 Low Price

2.3 Hybrid

2.4 Differentiation

2.5 Risky High Margins

This comprehensive analysis can help wet market sellers and even young businesses recognize efficient business practices for addressing direct competition in case they find themselves in a competitive market.

The study is anchored on Cliff Bowman and David Faulkner's Bowman's Strategic Clock (1996), which emphasizes exploring options for strategic positioning. The theory provides a variety of strategic options that a business can think about to obtain an edge over competitors. The five Bowman's Strategic Clock includes possible tactics used by the fish vendor at Silang Wet Market to obtain a competitive edge: Low Price and low value added. Since businesses often sell a common product, they use this strategy to attract customers by offering products or services at the lowest price in the market. The second strategy is the Low Price. This strategy involves selling a large volume of products at a low cost. The third business tactic is the price of the Hybrid. This pricing model combines fixed-rate and usage-based options.

In this strategy, businesses can charge customers for any service or product fee, providing good value at a lower price than competitors. Fourth is the Differentiation. This is where a business aims to give the customers a unique product. This way, selling a high-priced product or service is reasonable as they focus on uniqueness. Finally, the Risky High Margin, where a company charges high prices while providing low value and taking a risks which is based on brand image. Given its emphasis on market competitiveness, this theoretical framework will guide examining business strategies. It aims to provide insights into how wet market sellers position themselves strategically when facing competitors. It also assists us in identifying potentially effective strategies used by vendors in the Silang market.

III. Methodology

The researchers used a quantitative research design that investigated the effective strategies employed by wet market vendors with direct competitors in the Silang market. Descriptive Research Design is a methodology that systematically gathers information to describe a phenomenon, situation, or population. It aimed to address questions related to the research problem's what, when, where, and how aspects instead of delving into the reasons behind it (McCombes, 2019).

Moreover, this study applied a purposive sampling technique to select respondents based on the specific criteria formulated by the researchers. Purposive Sampling, or judgmental or selective sampling, is a research technique that uses non-probability sampling. Rather than relying on random selection, researchers used purposive sampling to pick specific individuals or items from a group based on specified criteria or their judgment (Nikolopoulou, 2022).

Additionally, the respondents in this study were the vendors at Silang wet market. The researchers selected a maximum of 30 individuals. The respondents were chosen based on three criteria: they must be wet market vendors of fresh meat, must have at least three years of experience managing a small business in the wet market, and must have a wet market stall at Silang Wet Market, Cavite.

Furthermore, the study used an adapted, modified survey questionnaire. Therefore, the group of academics was allowed to compile and develop some questionnaires from the previous research study that would entirely correlate to the SOP of the study. After the survey was completed, researchers created a permission letter as consent and introduced the chosen individuals

to the study. Hence, pilot testing was executed to ensure the credibility of the questionnaires. Lastly, the researchers proceed with the data collection process.

The group of researchers used percentage, frequency, and weighted mean as statistical treatment of data, which proves vital in assessing the effectiveness of strategies used by wet market owners or vendors in facing direct competition. It is easier to illustrate strategy distribution with frequency and percentage calculations, clarifying how many vendors use particular strategies and which are the most effective. At the same time, the weighted mean helped us see how effective the business strategies used by the wet market vendors are.

SCALE RANGE	VERBAL INTERPRETATION
3.26 - 4.00	Highly Effective
2.51 - 3.25	Effective
1.76 - 2.50	Less Effective
1.00 - 1.75	Not Effective

IV. Results

Problem 1. Demographic profile of the respondents in terms of:

1. Kind of Product

1.1 Years (experience)

Table 1.

Kind of product

Kind of Product	Frequency (f)	Percentage (%)
Pork	17	56.67
Seafood/Fish meat	7	23.33
Beef	3	10.00
Chicken	3	10.00
TOTAL	**30**	**100%**

Table 1. presents demographic information on the types of products wet market vendors offer.: 7 (23%) of the respondents were selling seafood or fish meat, 17 (56.67%) of the respondents were selling Pork, 7 (23.33%) of the respondents were selling seafood/fish meat, 3 (10%) of the respondents were selling beef, 3 (10%) of the respondents were selling chicken, while 0 is for carabeef. Among the 5 specific products, Pork secured the highest frequency (17) percent (56.67%). The pork had rapid growth rates and high feed-to-meat conversion ratios. They are simple to maintain, and require little space; they have successful reproductive potential (Brody, 2017).

Table 1.1

Years of experience

Years (experience)	Frequency (f)	Percentage (%)
3-10	24	80
11-30	5	16.67
31-50	1	3.33
TOTAL	**30**	**100%**

On the other hand, Table 1.1 displays their years of experience in Silang's wet market: 24 represents (80%) of the respondents' experience over the last three to ten years, five represents (16.67%) of the respondents' experience over the last eleven to thirty years, and one represents (3.33%) of the respondents' experience over the last thirty-one to fifty years.

Problem 2. Effective Strategies of Wet Market Vendors with Direct Competitors at Silang Market in terms of:

2. Low Price & Low Value-Added

2.1 Low Price

2.2 Hybrid

2.3 Differentiation

2.4 Risky High Margin

Table 2.

Low Price & Low Value-Added

Indicators	Weighted Mean	Verbal Interpretations
1. Charging cheaper prices than our competitors.	3.13	Effective
2. We have access to low-value raw fish/meat than our competitors allowing us to cut our prices.	3.43	Highly Effective
3. Practicing tight cost control to reflect our low-value product/services and boost our business profitability.	2.86	Effective
4. We strive to reduce costs in holidays while retaining the fixed value of our product & services.	3.13	Effective
5. We do not focus on product design techniques/ development.	2.66	Effective
TOTAL WEIGHTED MEAN	**3.04**	**Effective**

Table 2. depicts the vendors' responses under the Low Price and Low Value-Added strategy. Among the 5 specific indicators, *We Have Access to Low-Value Raw Fish/Meat Than Our Competitors, Allowing Us to Cut Our Prices,* secured the highest weighted mean of 3. 43 and was interpreted as Highly Effective. Access to low-quality goods was a good weapon when utilizing Low Price and low Value-Added. If a supplier offers low-value goods, vendors may also be able to sell them at a cheaper price (Kenton W., 2022). On the other hand, *We Do Not Focus On Product Design Technique/ Development* attained the lowest weighted mean of 2.66 and was still interpreted as Effective. When using Low Price and Low Value-Added, strictly focusing on product design or development will be a waste of time, given that this approach primarily centers on keeping the value and price low (Parker, B., 2020). Overall, the Low Price and Low Value-Added had a weighted mean of 3.04 and appeared as a viable strategy to face direct competition. A low value-added strategy can apply to a product in several ways, including a lack of product innovation. Therefore, businesses cut their prices to compensate for the value of their products since the price is determined by what consumers are prepared to pay based on their perceived value. Through this method, businesses remain competitive, ensuring no competitor can undercut them (Hayes, 2023).

Table 2.1.

Low Price

Indicators	Weighted Mean	Verbal Interpretations
1. Charging cheaper prices than our competitors.	3.13	Effective
2. Investing in sales promotion.	3.20	Effective
3. Reducing the product cost during holidays.	2.50	Less Effective
4. Constantly practicing tight cost control increases our business profitability.	3.00	Effective
5. Identifying underperforming areas to cut prices.	3.16	Effective
TOTAL WEIGHTED MEAN	**3.00**	**Effective**

Table 2.1. shows the vendors' responses under the Low-Price strategy. Among the 5 specific indicators of this variable, *Investing in Sales Promotion* secured the highest weighted mean of 3.20 and was interpreted as EFFECTIVE. Sales promotion was a good strategy under Low Price that might generate immediate income for wet market vendors. Sales promotions such as giving discounts, loyalty programs, or buy one get one (BOGO) can be the vendors' enticement throughout the customer lifecycle since it easily allows them to cut the prices of their product, resulting in attracting more consumers (Van Heerde & Neslin, 2017).

On the other hand, *Reducing the Product Cost During Holidays* attained the lowest weighted mean of 2.50 and was interpreted as Less effective. Due to higher store traffic, such as restocking, assisting many customers, cleaning, and bagging have become more urgent. As a result, the holiday-period cost of prices may increase dramatically for some businesses (Wiley, 2014). Overall, the Low Price has a weighted mean of 3.00 and appears a viable strategy to face direct competition. This approach offered a relatively low price to stimulate demand and gain profit. It is vital in establishing a sustainable competitive advantage for businesses. Many consumers regularly indicated that they are content with low-price offerings. When the customers know that any business has a low price on a wide selection of products, they will generally be more inclined to choose, knowing they will receive a fairly low price (Abhijeet & Amir, 2018; Diop, 2022).

Table 2.2.

Hybrid

Indicators	Weighted Mean	Verbal Interpretations
1. Charging cheaper prices than our competitors.	3.5	Highly Effective
2. Focusing on product design strategies.	3.16	Effective
3. Offering quality products & professional services to customers at low costs.	3.6	Highly Effective
4. Our major expenditure focuses on product quality.	3.33	Highly Effective
5. Providing discounts to customers.	3.36	Highly Effective

TOTAL WEIGHTED MEAN	**3.39**	**Very Effective**

Table 2.2. depicts the vendors' responses under the Hybrid strategy. Among the 5 specific indicators, *Offering Quality Products & Professional Services to Customers at Low Costs* secured the highest weighted mean of 3.6 and was interpreted as Highly Effective. On the other hand, *Focusing on Product Design Strategies* attained the lowest weighted mean of 3.16 and is still interpreted as Effective. One of the major purposes of the Hybrid strategy was to provide customers with high-value products through reduced cost. Therefore, cutting prices while integrating multiple design strategies to improve product quality and distinctiveness could lead to a smooth implementation of the Hybrid strategy (Syst Manag, 2023). Overall, the Hybrid had a weighted mean of 3.39 and appeared as a viable strategy to face direct competition. One of the major purposes of this strategy is to provide customers with high-value products at a reduced cost. As a result, when wet market vendors try to offer quality products at cheaper prices, they are more likely to attract customers because most consumers now prioritize lower-priced products with greater value (Wagner, 2018).

Table 2.3.

Differentiation

Indicators	Weighted Mean	Verbal Interpretations
1. Providing our customers with professional service.	3.56	Highly Effective
2. Focusing on the reputation of our products and service.	3.46	Highly Effective
3. Identifying our consumers' needs and wants.	3.8	Highly Effective
4. Focusing on product design/quality strategies.	3.86	Highly Effective
5. Giving discounts to those loyal customers.	3.63	Highly Effective

TOTAL WEIGHTED MEAN	**3.66**	**Very Effective**

Table 2.3 shows the vendors' responses under the Differentiation strategy. Among the 5 specific indicators, *Focusing on Product Design and Quality Strategies* secured the highest weighted mean of 3.86 and was interpreted as Highly Effective. On the other hand, *Focusing on The Reputation of Our Products and Services* attained the lowest weighted mean of 3.46 and was still interpreted as Highly Effective. Overall, differentiation had a weighted mean of 3.66 and appeared the most effective strategy to face direct competition. This strategy was particularly beneficial for vendors who prioritized the uniqueness of their products over their competitors. It was said that ensuring the uniqueness and value of the product is a top priority for all businesses, as it significantly contributes to achieving customer satisfaction. Furthermore, manufacturing organizations' success hinges on their ability to adapt strategic planning and integrate internal and industry-specific factors into differentiation strategies. (Lone & Bhat, 2023; Islami & et al., 2020).

Table 2.4.

Risky High Margin

Indicators	Weighted Mean	Verbal Interpretations
1. Charging higher prices than our competitors.	2.3	Less Effective
2. Constantly practicing high-cost control and giving customers low-value products/services to increase our business profitability.	3.00	Effective
3. Prioritizing higher pricing over product design techniques.	2.73	Effective
4. We have access to low-cost raw fish/meat than our competitors.	2.89	Effective
5. Increasing the product prices during holidays while retaining the fixed value of our product & services.	2.93	Effective
TOTAL WEIGHTED MEAN	**2.77**	**Effective**

Table 2.4. depicts the vendors' responses under the Risky High Margin strategy. Among the 5 specific indicators, *Constantly Practicing High-Cost Control and Giving Customers Low-Value Products and Services to Increase Our Business Profitability* secured the highest weighted mean of 3.00, interpreted as Effective. While *charging higher prices than our competitors* attained the lowest weighted mean of 2.3, interpreted as Less Effective, Overall, the risky high margin had a weighted mean of 2.77 and is still considered effective, yet it appeared the least effective among the first five strategies. Originally, this approach was entirely in charge of charging high prices while providing low-value products. However, most customers will look for a higher-quality product in a similar price range or the same product at a lower price to reduce costs while gaining value for money. In addition, charging a higher price for the product or service without simply stating the benefits to consumers is difficult in a competitive market (Sridharan, 2021).

V. Discussion

Competition is a threat to businesses, but it is still evident that the number of competitors inside wet market vendors has grown in recent years. Therefore, the researchers have chosen to explore the effective strategies of wet market vendors with direct competitors. This study can help proprietors expand their competitive edge, knowing direct competition is a serious issue among businesses that may cause some enterprises to fail after the researchers have found the results after the data-gathering procedure. Based on the data gathered, Differentiation is the most commonly used and effective approach among wet market vendors in facing direct competition, given that all indicators under this strategy have been evaluated as highly effective. Differentiation is how a business strives to provide customers with a unique product or service. Vendors at Silang Market are focused on unique marketing strategies to develop a competitive advantage and boost their profits compared to their competitors. Aside from that, researchers have also proven that the other four strategies are efficient: Hybrid is also evaluated as effective because most consumers nowadays prefer lower-priced products that provide high value.

Moreover, most wet vendors have also voted for Low Price/Low Value-Added and Low Price as effective strategies, signifying that both low and low value are critical in generating a sustained competitive advantage. Lastly, the Risky High Margins attained the lowest data among

the four strategies but were still considered effective. In conclusion, all five strategies are effective in dealing with direct competition based on the findings of this study.

The study's weakness is that it only evaluates the effective strategy of wet market vendors with direct competitors, ignoring any potential constraints or restrictions. This overlook may result in insufficient knowledge of each strategy's overall effectiveness and impatience; future researchers should conduct a more in-depth examination that considers both the pros and cons of each approach to address the limitations of this study. This may allow vendors to improve decision-making processes while providing a broader perspective on the strategy's effectiveness.

Also, the data shows that practically all five business strategies are beneficial in dealing with direct competition. As a result, it is advised to employ these strategies in the wet market and businesses that are more likely to encounter a direct competitive landscape. However, it is vital to highlight that every method has an evaluated indicator. Thus, individuals must review and be more observant of the entire study. Researchers also encourage vendors, business owners, and young entrepreneurs to prioritize their products' value, pricing, and distinctiveness. According to the data, emphasizing value has proven effective; nevertheless, it still depends on the strategy adopted, as each approach has its way of satisfying consumer perceived value.

Furthermore, it is encouraged for business owners to adopt a cost leadership approach, since prices are arbitrary in business. Lastly, consider how to market goods. There are several ways to promote products, but because Differentiation is the most effective strategy, the researchers recommended using this approach. Knowing Risky High Margin is the least effective according to the findings, the group of academics commended focusing more on the first four strategies rather than this particular method.

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Custom-Built Document Request System

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I. Abstract

The Custom-Built Document Request System is a website-based system intended to be utilized by the Registrar's Office to provide a better way of requesting documents, especially among the students at Olivarez College Tagaytay. The current system of obtaining documents is perceived as "inconvenient" by most of the requesters who personally experienced issues concerning document requests from the Registrar's Office. These issues include long queues and a lack of updated release dates. This study aimed to provide a more straightforward, quicker, and more efficient document-requesting process in comparison to the existing traditional manual process. The researchers used the Capstone Project as a research design. A total of 349 senior high school respondents were selected using the stratified sampling technique with Slovin's formula. The researchers utilized an adapted survey questionnaire, and the data was analyzed using a weighted mean. The results showed that the Custom-Built Document Request System for the Registrar's Office, which was tested by the respondents, obtained great marks in terms of effectiveness and acceptability in each of the four (4) categories that were evaluated, demonstrating that the system is capable of carrying out all necessary functions effectively with regards to providing accurate information about the system while also being considered excellent by respondents. Future researchers are advised to utilize student numbers as a part of identification in the user's account, as well as an online receipt on the said system, to have an easier confirmation upon receiving the requested document.

Keywords*: Document Request, Registrar Office, Capstone Project, Website*

II. Introduction

Paper-based methods require students and parents to physically visit a school or district office to submit a document request and, if necessary, pay for the order. The existing approach of requesting documents at Olivarez College Tagaytay (OCT) needs to be improved in terms of responses and updates for each student's requests. As the number of students requesting documents grows, so does the need for improvements in the registrar's process (Vogeler, 2022). The custom-built document request system is a website-based system intended to be utilized by the Registrar's Office to provide a more convenient and problem-free method of retrieving documents. The user can request papers online through this website, allowing the Registrar's Office to handle students' needs more effectively and efficiently. OCT already has a website for these kinds of instances to be dealt with, but given that the said website is not always functional, according to the Office of Student Affairs (OSA), it raises difficulties, particularly within the aforementioned educational institution.

Based on the interview conducted by the researchers, some students personally experienced the inconvenience that the current system of the Registrar's Office holds. These issues include long queues and knowing for a fact that as time went on, OCT enrollees ascended over the previous school year. Meanwhile, the majority of students noted that it was a "hassle" and time-consuming for the reason that most of the students lived far away from the said campus. Additionally, those seeking records may also be required to call or email the Registrar's Office to inquire about the status of their request. This can be frustrating, especially for students, if a filing records deadline is approaching. The researchers concluded that the existing system of the Registrar's Office is the main concern when requesting a document. For instance, teachers have to cope with document management and many manual tasks. Also, upon request, the Registrar's Office requires both students and registrars to invest important time and effort to complete a transaction, but this method is not an optimal choice. When a busy educational institution grows, relying on a manual requisition can be extremely cumbersome, resulting in many challenges and difficulties for the requesters. Each request must be processed quickly and effectively. (Abang et al., 2022).

Consequently, students have to deal with their document request submission manually without physically knowing the status of the requested documents. Thus, there is an obvious need to modernize the school document processing system. In order to resolve these concerns, the

researchers developed a website-based document request system wherein students can request specific documents without wasting time waiting in the Registrar's Office. The said system provides an organized process for each student to comply and track the status of their documents, resulting in an innovation compared to the old process, saving the time and resources of the Registrar Office. This simply means that as technology progresses, inventive solutions to manual requisition should be utilized to help both the students and the registrar. (Taruc et al., 2023).

The purpose of this study was to provide an efficient and accessible way to address the growing concern about obtaining documents in the OCT Registrar's Office. To make this system possible, the researchers utilized several programming languages such as Hypertext Markup Language (HTML) for the layout of the webpage and the fundamental building blocks of the said website, cascading style sheets (CSS for designing the webpage and applying style to the elements), and Hypertext Preprocessor (PHP) to create websites, applications, customer relationship management systems and more. Javascript will make the web page interactive, handle all functions, and use structured query language (SQL) to store all data in the database.

This study aimed to answer the following questions;

1. What is the level of effectiveness of using the Custom-built document request system in terms of:

1.1 Convenience

1.2 Reliability

1.3 Security and Privacy

1.4 Accessibility

2. What is the level of acceptability of the Custom-built document request system in terms of:

2.1 Interface

2.2 Neatness

2.3 User-friendliness

2.4 Responsiveness

The study focused on the centralized procedure of seeking a requested document in the OCT Registrar's office, making it easier for the students who are having a hard time upon retrieving

the requested documents. Hence, the system was constructed to provide a faster and more efficient process compared to the existing traditional manual document process.

A custom-built document request system enhances the current way of handling the document process of the registrar's office. By leveraging digital technologies, the researchers sought to rationalize and create a user-friendly website that enables students and the said educational institution to significantly benefit by making it more convenient to obtain relevant documents such as transcripts of records, enrollment certifications, and other academic documents. Furthermore, this study can be an outline for future inquiries by improving this topic. It might also be beneficial to future researchers and serve as a guide for later initiatives.

This study is anchored on the Technology Acceptance Model by (Fred's Davis, 1989). The technology acceptance model is an information systems theory that models how users come to accept and use technology. The actual system use is the end-point where people use the technology. Behavioral intention is a factor that leads people to use technology. Today, the world is increasingly reliant on the information technology sector to sustain innovation, which is determined by two factors: first, perceived benefit, and second, perceived simplicity of use. Lastly, the emphasis on the potential user's perception is a fundamental component of this framework. The importance of this theory to the researcher's study is significant as its innovation is dependent on how well the system is received by the users, as this indicates what needs to be improved for it to be more acceptable to the users.

INPUT	**PROCESS**	**OUTPUT**
KNOWLEDGE REQUIREMENTS ● Knowledgeable about using and knowing what programming language would be used. ● Knows how to store and retrieve data using SQL.	**PLANNING** ● The current state of the registrar's manual document request system is a hassle, and time-consuming that delays the students' time to obtain their documents. **SYSTEM ANALYSIS** ● A web-based system in which students can request to retrieve their	Custom-Built Document Request System for Registrar office at Olivarez College Tagaytay

● Knowledgeable about designing web pages. **SOFTWARE REQUIREMENTS** **a. Platform** ● Visual Studio Code **b. Identification** ● PHP ● CSS ● JavaScript ● HTML ● Bootstrap ● SQL	documents in less time, which can be hassle-free and prevents delaying of processing documents while benefiting the registrar's office and the students. **SYSTEM DESIGN** ● Layout ● Flow Chart **DEVELOPMENT** ● Coding \ Programming ● Initial Testing **IMPLEMENTATION** ● Deployment of the project	

Figure 1. *Conceptual Paradigm (IPO Chart)*

The researchers selected the input, process, and output model (IPO Model) as a conceptual framework, in which they described the knowledge requirements that the study needs to fulfill the system that the researchers innovated and displayed the software requirements that were used. The researchers also input the process of planning the system, system analysis, system design, how it was developed, and the implementation of the system. Lastly, the researchers present the study output, which is the Custom-built document request system.

III. Methodology

The researchers utilized the Capstone Project research design since this study dealt with developing a system called the Custom-Built Document Request System. The capstone project demonstrates the student's capacity to grasp complex challenges, think critically, and implement innovative approaches (Singh, 2023). For instance, the aforementioned method was effective in

offering a better system at Olivarez College Tagaytay, particularly in providing a quick and efficient way of obtaining specific documents for academic purposes.

In this study, the researchers employed a stratified sampling technique with Slovin's formula. Stratified sampling is a probability sampling technique used in a sample survey which allows the researchers to examine their sample and create bias-free groups of people. The elements of the target population are separated into various groups or strata, with elements within each stratum similar to one another in terms of certain survey-relevant features (Parsons, 2017). Since there are a total of 2,700 Senior High School students in Olivarez College Tagaytay, the researchers solved "*n = N / (1+Ne^2)"* to calculate the sample size, thus resulting in a total of 349 grade 11 and grade 12 Senior High School students in all strands. Under the Information and Communication Technology (ICT) seventy (70), Home Economics (H.E.) sixty-nine (69), Accountancy, Business and Management (ABM) seventy (70), Science, Technology, Engineering, and Mathematics (STEM) seventy (70), and Humanities and Social Sciences (HUMMS) seventy (70).

The researchers utilized an adapted, modified questionnaire from a previous study named "Effectiveness of InterClass Communication Website for Students and Teachers of Olivarez College Tagaytay" (Gonzales, 2022).

The researchers obtained authorization from the principal to conduct the study and created concept notes for the research supervisor and respondents. In addition, the researchers gave the respondents access to the system. Then, the researchers handed the survey questionnaires to the respondents. Finally, the researchers counted and examined the data containing the feedback of the respondents and then moved on to the final stage of analysis.

To present themselves with a definitive outcome, the researchers utilized statistical treatment. To arrive at a definite result, the following scale rance was used to determine the level of effectiveness and acceptability of the Custom-built document request system for the Registrar's Office in Olivarez College Tagaytay.

RANGE	QUALITATIVE DESCRIPTION
3.26 - 4.00	Highly Effective
2.51 - 3.25	Effective
1.76 - 2.50	Slightly Effective

1.00 - 1.75	Not Effective

RANGE	**QUALITATIVE DESCRIPTION**
3.26 - 4.00	Highly Acceptable
2.51 - 3.25	Acceptable
1.76 - 2.50	Slightly Acceptable
1.00 - 1.75	Not Acceptable

Figure 2.

User's database

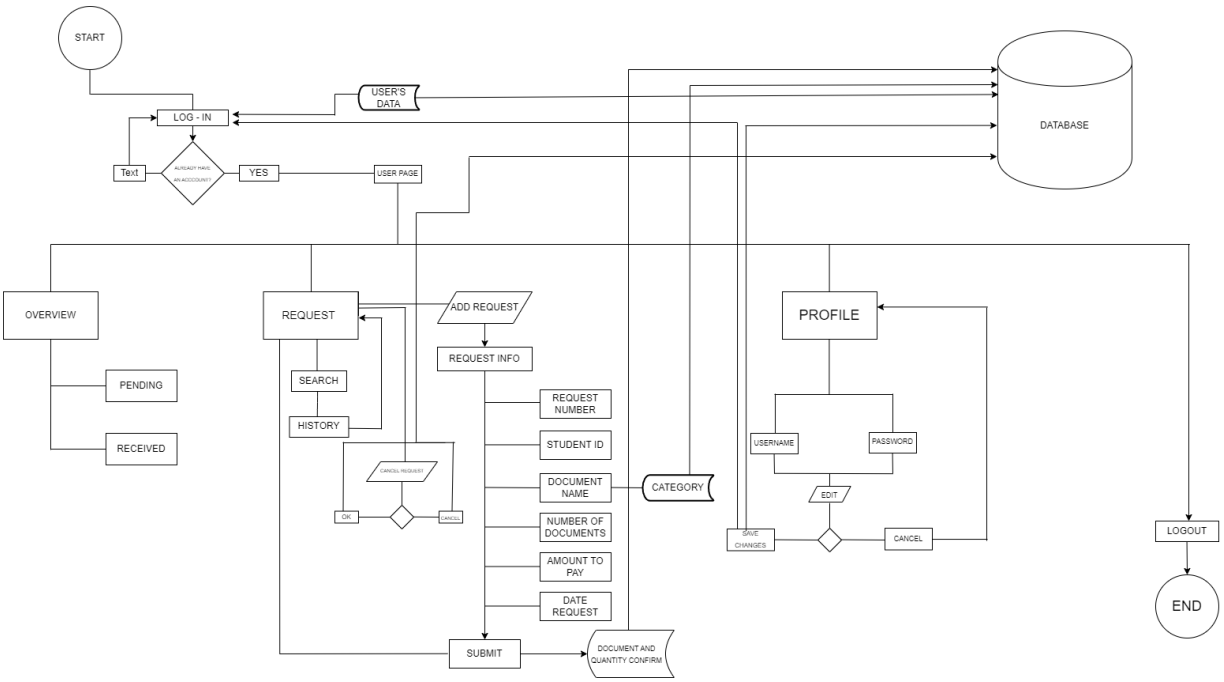
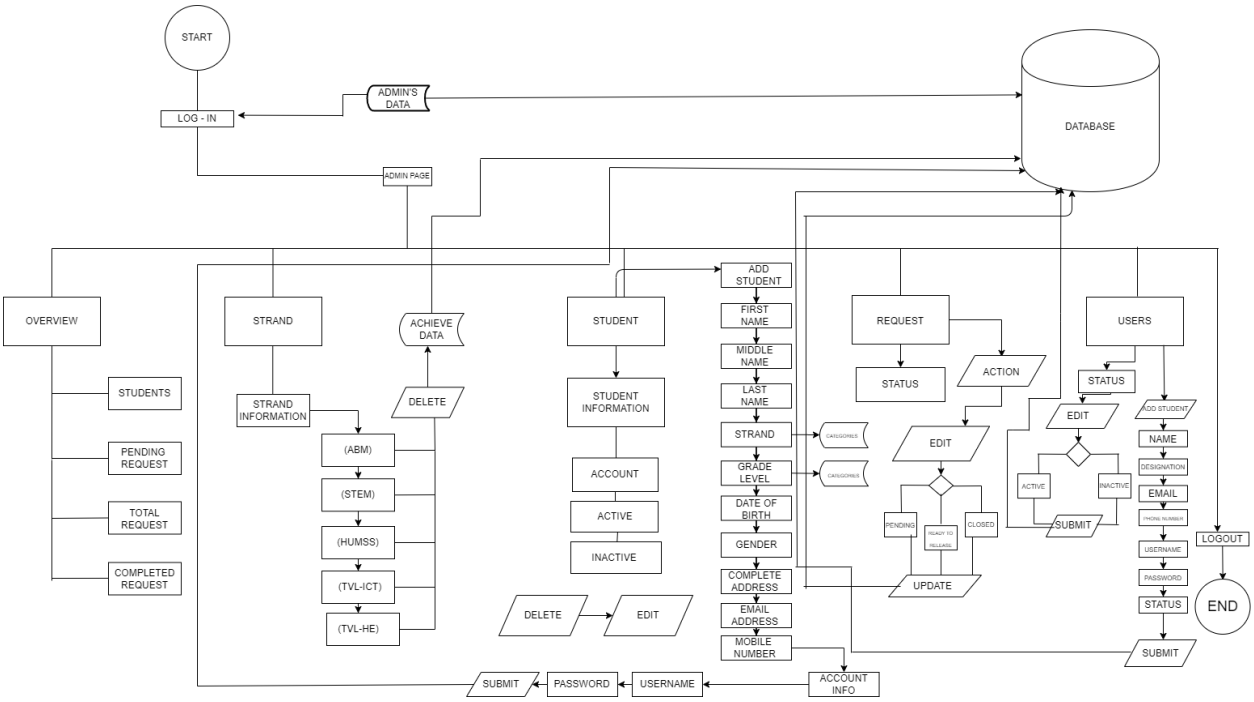


Figure 3.

Admin Database



IV. Results

Problem 1. What is the level of effectiveness of using the Custom-built document request system in terms of:

1.1 Convenience

1.2 Reliability

1.3 Security and Privacy

1.4 Accessibility

Table 1.

Level of Effectiveness of Custom-Built Document Request System

I. Convenience - Indicators	**Weighted Mean**	**Verbal interpretation**
1. It provides a faster way of attaining documents in the registrar's office compared to the manual system	3.66	Highly Effective
2. It can perform specific tasks based on its intended functions	3.60	Highly Effective
OVERALL MEAN	**3.62**	**Highly Effective**
II. Reliability – Indicators	**Weighted Mean**	**Verbal interpretation**
1. It meets the needs under reliability to perform requesting documents for academic purposes	3.63	Highly Effective
2. It provides identification and authorization to each user through username and password	3.70	Highly Effective
OVERALL MEAN	**3.66**	**Highly Effective**
III. Security and Privacy - Indicators	**Weighted Mean**	**Verbal interpretation**
1. It meets the user's data security standards	3.59	Highly Effective
2. It corresponds to the directory structure to avoid data breaching	3.63	Highly Effective
OVERALL MEAN	**3.61**	**Highly Effective**
IV. Accessibility - Indicators	**Weighted Mean**	**Verbal interpretation**
1. The system meets the availability standard in the student	3.59	Highly Effective
2. The system is easy to access and utilize.	3.63	Highly Effective
OVERALL MEAN	**3.61**	**Highly Effective**
GRAND MEAN	**3.62**	**Highly Effective**

Table 1 presents the level of effectiveness of the Custom-Built Document Request system among students at Olivarez College Tagaytay. First, in terms of convenience, among the two (2) specific indicators, *"It provides a faster way of attaining documents in the registrar's office compared to the manual system"* attained the highest weighted mean score of 3.66, which is verbally interpreted as highly effective while *"It can perform specific tasks based on its intended functions"* attained the lowest weighted mean with the score of 3.60 but still, is linguistically interpreted as highly effective. The system was rated very effective in terms of convenience, given that it is capable of yielding accurate results regardless of its intended function. In real-time, computerization will greatly reduce the time needed to complete the overall process. It correlates with an automated system simply because it will be beneficial for the educational institution as it performs the same thing manually. Merely stated that the manual process is quite insufficient (Ahmed et al., 2019).

Second, in terms of reliability in user effectiveness, among the two (2) specific indicators, "*It provides identification and authorization to each user through username and password"* obtained the highest weighted mean score of 3.70, which is verbally interpreted as highly effective, while "*It meets the needs under reliability to perform requesting documents for academic purposes"* attained the lowest weighted mean score of 3.63 but also verbally interpreted as highly effective. It implies that a user's login and password can be used for authentication and identification purposes themselves. In "The Asian Journal of Natural & Applied Sciences", Upon verifying the request on the website, requesters can send their online requests to the administrator directly for or her query (Aziz, 2015). Moreover, there is a small hindrance to the need for dependability during the usual operations. Nevertheless, a crucial component of software quality, reliability, is extremely important for online service software. Any unexpected failure can be a starting point for service disruptions if service reliability cannot be accurately anticipated (Ding et al., 2014).

Third, in terms of security and privacy by users, among the two (2) specific indicators, "*It meets the user's data security standards"* attained the highest weighted mean score of 3.59, which is verbally interpreted as highly effective, whilst*" it corresponds to the directory structure to avoid data breaching"* attained the lowest weighted mean with the score of 3.63 which is verbally interpreted as highly effective. The data indicates that the system is highly secured and ensures its

privacy. It simply offers some introductory information on technological advancement, the penetration of the Internet into all aspects of our lives, and its associated conveniences. It then discusses the vulnerability of internet services, presents some typical attack cases that are mostly carried out by smart home appliances, and explains security implementation obstacles on such devices from technical, social, and practical aspects. It offers an appropriate security model, demonstrates important countermeasures for numerous attack scenarios, and explains why and how numerous stakeholders need to get together for its commercial implementation (Pishva, 2017).

Lastly, in terms of accessibility, among the two (2) specific indicators, "*The system is easy to access and utilize*." attained the highest weighted mean score of 3.63, which is verbally interpreted as highly effective. However, "*The system meets the availability standard in the student"* obtained the lowest weighted mean score of 3.59, which is still verbally interpreted as highly effective. The data indicates that the system is highly effective when it comes to accessibility, especially among students. The development of a software product needs to be evaluated to ensure that it meets the objective. There are several ways to evaluate a software product. Software is thoroughly tested for functionality, usability, completeness, and acceptance. The evaluation of said components that were evaluated are the speed of the system's performance, rate of error, user retention of command over time, user satisfaction, terminology used, screen testing and learning ability, and the acceptance towards the website (Barahudin et al., 2015).

In all areas, convenience received a total weighted mean score of 3.62; reliability received a total weighted mean score of 3.66; security and privacy obtained a total weighted mean score of 3.61; and accessibility obtained a total weighted mean score of 3.61. The level of effectiveness of the said system obtained an overall weighted mean score of 3.62. As a result, all four (4) categories are verbally interpreted as highly effective. This signifies that the Custom-built document request system has an overall high level of effectiveness from the user's standpoint, in the sense that it works easily enough for the user to navigate and remember every distinctive button and its intended use.

Problem 2. What is the level of acceptability of the Custom-built document request system in terms of:

2.1 Interface

2.2 Neatness

2.3 User-friendliness

2.4 Responsiveness

Table 2.

Level of Acceptability of Custom-Built Document Request System

I. Interface - Indicators	**Weighted Mean**	**Verbal Interpretation**
1. The system interface is eye-catching to the users	3.53	Highly Acceptable
2. The system interface perfectly matches the user's preferences	3.57	Highly Acceptable
OVERALL MEAN	**3.55**	**Highly Acceptable**
II. Neatness - Indicators	**Weighted Mean**	**Verbal Interpretation**
1. The system has a simple and clean user interface	3.69	Highly Acceptable
2. The system's usability is maximized to deliver a simple outcome	3.61	Highly Acceptable
OVERALL MEAN	**3.65**	**Highly Acceptable**
III. User Friendliness - Indicators	**Weighted Mean**	**Verbal Interpretation**
1. The system has effective navigation for users.	3.62	Highly Acceptable
2. The system has simple functions that are easy to understand.	3.65	Highly Acceptable
OVERALL MEAN	**3.63**	**Highly Acceptable**

IV. Responsiveness - Indicators	Weighted Mean	Verbal Interpretation
1. The system user's interface automatically adjusts for various screen sizes	3.61	Highly Acceptable
2. The user interface content position is responsive in various screen sizes	3.63	Highly Acceptable
OVERALL MEAN	**3.62**	**Highly Acceptable**
GRAND MEAN	**3.61**	**Highly Acceptable**

Table 2 presents the level of acceptability of the Custom-Built Document Request system among students at Olivarez College Tagaytay. In terms of interface, among the two (2) specific indicators, "*The system interface is eye-catching to the users"* attained the highest weighted mean score of 3.57, which is verbally interpreted as highly acceptable. Meanwhile, "*The system interface perfectly matches the user's preferences"* attained the lowest weighted mean score of 3.53, which is still verbally interpreted as highly acceptable. The data indicates that the system's interface is visually pleasing. In order to attract prospective students to visit the university website, the components of the user interface should be taken into consideration. Website interface is one of the factors as a medium of communication between the website and potential users such as students. The components of the interface that are used mostly in research are metaphor, navigation, mental model, interactions, and appearance. (Alexander & Ishak, 2018)

Second, in terms of neatness in the user's level of acceptability, among the two (2) specific indicators, "*The system has a simple and clean user interface"* obtained the highest weighted mean score of 3.69, which is verbally interpreted as highly acceptable. "*The system's usability is maximized to deliver a simple outcome"* obtained the lowest weighted mean score of 3.61, which is verbally interpreted as highly acceptable. The data indicates that the system is orderly and organized. Minimalistic design has reduced complexity in much of the technology we use today, making it accessible to a wider audience. Minimalistic designs can be a factor in the satisfaction of the users, especially in terms of design. Mobile applications are the most successful in attempting to minimize the various amounts of user input needed to provide the information that the user is looking for (Sumanth, 2019).

Third, in terms of user-friendliness by the level of acceptability, among the two (2) specific indicators, "*The system has simple functions that are easy to understand."* attained the highest

weighted mean score of 3.65, which is verbally interpreted as highly acceptable while "*The system has effective navigation for users"* attained the highest weighted mean score of 3.62 which is also verbally interpreted as highly acceptable. The data indicates that the system meets the requirements of being a user-friendly website. A user-friendly website is most likely to be accepted by a potential user because, by utilizing a friendly website, users can comprehend it very easily, resulting in a satisfied user. Moreover, producing a friendly website provides clear and concise information (Hombali, 2023).

Lastly, in terms of responsiveness, among the two (2) specific indicators, "*the system user's interface automatically adjusts for various screen sizes"* attained the highest weighted mean score of 3.63, which is verbally interpreted as highly acceptable. On the other hand, "*The user interface content position is responsive in various screen sizes"* attained the lowest weighted mean score of 3.61, which is verbally interpreted as highly acceptable. The data indicates that the system is efficiently responsive when conducting a specific action or request. It is shown that a responsive approach provides greater website support for all devices. This is achieved thanks to its particular advantages, including the use of HTML and CSS code to display a website on all devices and adapting the content to the width of the browser. The primary components that are used in this approach are theoretically described, and the actual examples are given. To be specific, the relative values used for each given width of the container and child elements, as well as the uses of media queries for laptops, tablets, and mobile phones. The approach is investigated as an independent web development philosophy and also as an essential part of responsive webpage layout, as its advantages and disadvantages. (Filippova & Svidelskyi, 2016)

In all areas, the interface attained a total weighted mean score of 3.55; neatness received a total weighted mean score of 3.65; user-friendliness obtained a total weighted mean score of 3.63; and responsiveness obtained a total weighted mean score of 3.62. The level of acceptability of the said system obtained an overall weighted mean score of 3.61. As a result, all four (4) categories are verbally interpreted as highly acceptable. This signifies that the Custom-built document request system has an overall high level of acceptability from the user's viewpoint; this indicates that the students agreed on how the system ought to work in terms of producing results based on its intended function and that the system is capable of fulfilling all tasks that are required.

V. Discussion

Institutions, particularly Olivarez College Tagaytay, have historically depended on manual and occasionally cumbersome document requests. The Custom-built document request system enables the Registrar's personnel to keep track of all of their event recording processes and to analyze the performance of all of its transactions in a way that is more efficient and effective. This study offers a better solution in terms of providing a sufficient way in terms of giving solutions to the arising concerns.

Substantially, the Custom-built document request system has a great degree of effectiveness in terms of security and privacy, convenience, accessibility, and responsiveness. This indicates that the system is capable of implementing all required functions. These resources offer an alternative way to traditional laboratory settings hosted at educational institutions, where many studies utilize students as the available and accessible population. Likewise, the Custom-built document request system is highly acceptable in terms of interface, neatness, user-friendliness, and responsiveness. According to several of the faculty members, it is rather useful when obtaining a document, knowing for a fact that there are some concerns going around, especially when it comes to attaining a document in the Registrar's Office.

The Custom-Built Document Request System for Registrar Office at Olivarez College Tagaytay offers a better way of requesting documents as the document request system provides an easier and more composed way of requesting desired files. However, the system does not support payment transactions, report sales, history receipts, super admins, and receipt printing. The system is only capable of requesting specific documents that the user requested. Each user can proceed with the payment to the Registrar's Office. Upon receiving the said requested documents, the students must bring their Identification Card (ID) for confirmation in the Registrar's Office.

The researchers recommend that future researchers concentrate more on the online receipt and utilize the student number upon requesting a document to have concrete proof of each student when claiming the necessary document in the Registrar's Office. To add, the researchers also recommend utilizing super admin in this study to give the Custom-Built document request system full authorization upon operating the system this can help manage and enhance the system since the researchers only provided a request overview for the documents that are still in process.

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The Level of Engagement of the Youth in the Community Activities of Sangguniang Kabataan in selected Barangays in Silang, Cavite

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I. Abstract

Community engagement plays a crucial role in every youth. In Silang, Cavite, it is concerning that there is insufficient study about the engagement of the youth in the different community activities of Sangguniang Kabataan. Thus, the researchers set out to identify the youth's engagement level in community activities such as Community-driven, Health-related, Sports-related, and School-related. The researchers employed a Quantitative Descriptive Research Design to describe the possible reasons for the youth's participation in community activities. Using the Purposive Sampling Technique, the researchers selected respondents using a criteria. The results indicated that the level of youth engagement across community-driven, health-related, sports-related, and school-related activities showed that most youths under 17-18 and females are more likely to engage in the said activities. Among all the activities, the results showed that youth are more engaged in community drive-related activities, followed by sports-related activities, health-related activities, and school-related activities. The study was limited to ten out of sixty-four barangays due to time constraints and the location of each barangay in Silang, Cavite. Therefore, the researchers recommend future studies on a wider scope of demographical location to know the level of engagement of youth in future SK community-based activities in different areas in Cavite. Also, future researchers should explore other activities implemented by each barangay that may help increase residents' engagement in barangay activities, including why some people are not engaged in the activities.

Keywords: *Sangguniang Kabataan, level of engagement, youth engagement, community drive-related, health-related, sports-related, school-related, community-based activities*

II. Introduction

As a pillar of youth development, the Sangguniang Kabataan produced a generation of knowledgeable, capable, and socially aware people ready to guide their communities toward a better future. According to the National Youth Commission, the Local Government Code of 1991 gave rise to the Sangguniang Kabataan (SK). In December 1992, the first SK leadership election took place. The Sangguniang Kabataan comprised an elected chairman, seven members, a secretary, and a treasurer (Garcia, 2023). The engagement and active participation in community activities implemented by Sangguniang Kabataan officials could lead to social and community development. The Sangguniang Kabataan was crucial for youth development, promoting knowledge and leadership among adolescents. It aided in developing responsive policies and programs, promoting health and well-being (Connolly et al., 2020). We should have prioritized initiatives covering the issues of youth participation, sustainability, empowerment, education, environment, climate, health, sports, and community development (Comprehensive et al. Plan, 2023).

The researchers found out that the youth's lack of interest and time limits to participation in SK community activities caught the attention of the youth leaders in barangays. However, the results of the preliminary survey conducted by the researchers on December 12, 2023, revealed that eight out of eleven activities provided to respondents were frequently participated in by young people. These activities included engagement in the barangay league, gift-giving programs, participation in *Brigada Eskwela* volunteering, clean-up drives, engagement in online mobile team-up games, availing of scholarships, accessing free incentives, and participating in recycling programs. Conversely, the survey indicated that youth less frequently participated in three of the eleven activities. These activities comprised involvement in feeding programs, seminars, and workshop participation. These findings highlight the varied levels of participation among youth in SK community activities and shed light on the more and less appealing activities. Understanding these participation patterns is crucial for designing targeted interventions and programs to foster greater youth engagement in SK initiatives.

Therefore, the study aimed to determine the youth engagement level in the community activities of *Sangguniang Kabataan* (SK) officials in selected barangays of Silang, Cavite.

Specifically, this study aims to answer the following questions:

1. What is the demographic profile of the respondents in terms of:

1.1 Age

1.2 Gender

1.3 Barangay

2. What is the level of engagement of the youth in the community activities in terms of:

2.1 Community drive-related activities

2.2 Health-related activities/seminars

2.3 Sports related activities

2.4 School-related activities

This study aimed to investigate the participation of youths in various community activities in the Municipality of Silang, Cavite. Out of the 64 barangays in Silang, the researchers selected 10 specific barangays: Barangay Buho, Malabag, Bucal, Lalaan 1st and 2nd, Santol, San Miguel 1st, Poblacion 1st, Tubuan 1st, and Toledo. The focus of the study encompasses community-driven initiatives, health-related engagements, sports activities, and school-related programs as evaluated by the Sangguniang Kabataan.

At this point, the researchers found significant points in conducting this study since it is essential for the youth to engage with the help of community leaders and activities. This study also supported and recommended ideas and practices that the Sangguniang Kabataan (SK) may use to enhance and improve their projects and activities in their community. This research study also benefits the community where they can gain a lot from having young people actively involved, such as having new ideas and perspectives, social awareness and advocacy, skill development, a sense of belonging, empowerment and leadership development, intergenerational collaboration, civic engagement, addressing issues unique to young people, and the promotion of a volunteer culture. This involvement strengthens the community's overall resilience and sustainability by fostering responsible and engaged citizens for the future.

This study is grounded in Olivier Serrat's Theory of Change (2017), which highlights the importance of careful planning when individuals or communities strive to achieve specific goals or bring about change. Implementing policies, strategies, programs, or projects within this framework is crucial for achieving desired results. Viewing the situation through this lens, it

becomes evident that community leaders adopt a varied approach, using different initiatives involving civilians, particularly the youth, to drive meaningful change across the community landscape. This comprehensive strategy underscores the proactive involvement of stakeholders and the deliberate design of interventions aimed at nurturing positive developments and addressing urgent societal challenges. Consequently, Serrat's theory serves as a cornerstone for framing the broader context of this study, providing researchers with valuable insights into the intricate dynamics between youth involvement and community-driven initiatives. By clarifying the interconnectedness between these elements, the theory provides a solid foundation for understanding the complexities inherent in community activities and youth's crucial role in shaping collective outcomes.

III. Methodology

The researchers of this study utilized Quantitative Descriptive Research Design. Descriptive research is used to precisely and methodically describe a population, circumstance, or phenomenon (McCombes, 2019). The researchers employed this design to describe the youth's engagement level in Sangguniang Kabataan's community activities in the ten selected local communities.

The researchers chose the different barangays in Silang, Cavite, as their research locale. The researchers used the Purposive Sampling Technique for this study. Purposive Sampling was a non-probability sampling technique used to select individuals or groups that met specific criteria relevant to the research question or objective (Hassan, 2023). The first requirement was that the respondent had lived in one of the 10 barangays. Secondly, the respondents must have lived in the same barangay for over five years. Lastly, the criterion is that the respondents must be ages 15 to 30. To gather the data information needed by the researchers, they utilized the Survey Questionnaire.

The researchers conducted a preliminary survey of 48 respondents last December 2023 from the Municipality of Silang, Cavite. Beforehand, the researchers asked the principal for permission to conduct their study outside the premises of the school campus. Then, the researchers put effort into finding ten final selected barangays as their research locale. The researchers also prepared copies of permission to conduct each barangay, which were noted by the research adviser,

approved by the school heads, and signed by the barangay chairman. Afterward, the researchers also requested a copy of youth profiling for the computation of the possible accumulated respondents in each barangay, they also requested a copy of narrative reports implemented by the previous SK Officials as guidance for the questionnaire.

After that, the researchers used a Likert scale to create a closed-ended survey questionnaire. The research adviser checked the survey questionnaire and then it was validated by a subject expert. Once the questionnaire was validated, the researchers converted it into Google Forms with the data needed by sending the link and providing a hard copy of the document. The researchers chose 15 respondents to answer the validated survey questionnaire. Once the respondents answered the Google forms provided, the researchers tabulated the data. After data tabulation, the data was analyzed using Cronbach's alpha to analyze the results of the pilot testing. The Cronbach result was 0.882414748, showing the pilot testing result was good. After passing the pilot testing, the researchers gathered data in the ten chosen barangays in Silang, Cavite. Giving every member an assigned area in said locale, the researchers gathered data on March 19–27, 2024.

During the data gathering, before they started gathering data from house to house, the researchers asked permission first from their parents—parental consent—allowing them to conduct the research in the selected barangays. Then, on the day of gathering the data, the researchers asked permission first from the barangay office and asked for some guidance from the office personnel. The data was gathered with the guidance of Sangguniang Kabataan Chairmans and Counselors. After gathering the data, the data was tabulated and analyzed with the help of a statistician.

After gathering the data, the researchers used a statistical treatment to analyze the survey questionnaire results. The demographic profile of the respondents was determined by percentage and frequency. Then, the researchers used the mean score to interpret the respondents' responses.

Scale Ranges	Adjectival Meaning	Quantitative Description
4.00 - 3.26	Always	Highly Engaged
3.25 - 2.51	Sometimes	Engaged
2.50 - 1.76	Seldom	Slightly Engaged
1.00 - 1.75	Never	Not Engaged

IV. Results

Problem 1. What is the demographic profile of the respondents in terms of:

1.1 Age

1.2 Gender

1.3 Barangay

Table 1.1
Age of the respondents

Age	Frequency (f)	Percentage (%)
15 - 16	63	17.50%
17 - 18	109	30.28%
19 - 20	90	25%
21 - 22	35	9.72%
23 - 24	30	8.33%
25 - 26	20	5.56%
27 - 28	9	2.50%
29 - 30	4	1.11%
Total	**360**	**100.00%**

Table 1.1 shows the frequency and percentage of the ages of the respondents. It shows that the youths from the selected barangays in Silang, Cavite ages 15 to 16 got a frequency of 63 or

17.50%, the frequency for ages 17 to 18 was 109 with a percentage of 30.28%, ages 19 to 20 got a frequency of 90 or 25%, ages 21 to 22 got a frequency of 35 with a percentage of 9.72%, and the frequency for ages 23 to 24 is 30 or 8.33%, while those aged 25 to 26 got 20 as the frequency or 5.56%. For ages 27 to 28, the frequency is 9 or 2.50%. Lastly, the frequency of ages 29 to 30 was 4 or 1.11%. The majority of youth in selected barangays in Silang, Cavite, were 17 to 18 years old.

Table 1.2
Sex of the respondents

Sex	Frequency (f)	Percentage (%)
Female	181	50.28%
Male	179	49.72%
Total	**360**	**100.00%**

Table 1.2 shows the frequency and percentage of sex per respondent. It shows that 181, or 50.28%, of the respondents, were female, and 179, or 49.72% were male. With a total of 360 respondents. It presents that most of the accumulated youth in selected barangays in Silang, Cavite, were female youths.

Table 1.3
Barangays resided by the respondents

Barangay	Frequency (f)	Percentage (%)
Buho	36	10.00%
Malabag	36	10.00%
Bucal	36	10.00%
Toledo	36	10.00%
Lalaan 1	36	10.00%
Lalaan 2	36	10.00%
Santol	36	10.00%
Tubuan 1	36	10.00%
Población Uno	36	10.00%
San Miguel 1	36	10.00%
Total	**360**	**100.00%**

Table 1.3 shows the frequency and percentage of the barangays resided by the respondents. It shows that the respondents were equally 36 or 10.00% of the respondents who each selected Barangay.

Problem 2. What specific community activities organized by the Sangguniang Kabataan are less likely to engage, in terms of:

2.1 Community drive-related Activities

2.2 Health-related Activities

2.3 Sports-related Activities

2.4 School-related Activities

Table 2.1
The Level of Engagement of the Youth in Community Drive-related Activities

Indicators	Mean Score	Adjectival Meaning	Verbal Interpretation
I am engaged in tree-planting activities.	2.68	Sometimes	Engaged
I am engaged in the Clean Up Drive Project.	2.90	Sometimes	Engaged
I am engaged in disaster preparedness drills.	2.83	Sometimes	Engaged
I am engaged in using trash bins.	3.50	Always	Highly Engaged
I am engaged in gift-giving projects.	2.88	Sometimes	Engaged
Total Mean	**2.96**	**Sometimes**	**Engaged**

Table 2.1 shows that statement 4, *"I am engaged in using trash bins",* got the highest mean score of 3.5 with an adjectival meaning of Always and was verbally interpreted as Highly Engaged. Home composting and the reduce-reuse-recycle (3Rs) approach are good ways for the community or young people to get involved in waste management. Young people may also be significant in spreading awareness and promoting behavior changes related to trash reduction, reuse, and recycling (Naldi, 2023). On the other hand, statement 1, *"I am engaged in tree planting activities",* got the lowest mean score of 2.68 with an adjectival meaning of Sometimes, and was verbally

interpreted as Engaged. Young people may not be interested in participating in tree-planting events because they are not exposed to natural settings or do not recognize the value of trees and the environment. The National Trust has drawn attention to the possibility that today's kids suffer from "nature deficit disorder" due to their insufficient outdoor experience, which might cause them to become disconnected from nature and its advantages (Balanac & Punzalan, 2020). Overall, the responses of the youth in community drive-related activities totaled a mean score of 2.96, verbally interpreted as Engaged. The fact that the score is above the midpoint of the scale indicates a positive degree of participation. It indicates that the youth in the chosen barangays in Silang, Cavite, are actively engaged in community activities linked to community drives. Youth are highly engaged in community-driven activities in their local communities when they are meaningfully involved, supported by adults, able to develop skills and contribute to addressing community needs - all of which foster a sense of efficacy, responsibility, and ownership among the youth (The Annie E. Casey Foundation, 2019).

Table 2.2
The Level of Engagement of the Youth in Health-related Activities

Indicators	Mean Score	Adjectival Meaning	Verbal Interpretation
I am engaged in first-aid training activities in my community.	2.80	Sometimes	Engaged
I am engaged in mental health awareness seminars in my community.	2.82	Sometimes	Engaged
I am engaged in drug-related seminars in my community.	2.60	Seldom	Slightly Engaged
I am engaged in attending a symposium about teenage pregnancy in my community.	2.33	Seldom	Slightly Engaged
I am engaged in seminars on proper hygiene in my community.	2.92	Sometimes	Engaged
Total Mean	**2.60**	**Sometimes**	**Engaged**

Table 2.2 shows that statement 5, *"I am engaged in seminars on proper hygiene in my community,"* got the highest mean score of 2.92 with an adjectival meaning of sometimes and was verbally interpreted as engaged. Hygiene education aims to raise awareness among people, families, and communities about the connections between unhygienic practices and illness. It also

entails supporting and assisting individuals in changing behaviors that, when altered, will result in the most significant decrease in illness (WHO, 2020). On the other hand, statement 4, *"I am engaged in attending a symposium about teenage pregnancy in my community,"* got the lowest mean score of 2.33 with an adjectival meaning of seldom and was verbally interpreted as slightly engaged. Youth's disinterest in adolescent pregnancy symposiums is due to stigma, which affects young mothers due to their undervalued ethnicity and defying social expectations. This stigma can lead to negative emotions, hinder efficient practice, and create obstacles to assistance, making it a significant obstacle for young people attending such events (SmithBatlle, 2020). Overall, the responses of the youth in health-related activities totaled a mean score of 2.60, which was verbally interpreted as Engaged. The fact that the score is above the midpoint of the scale indicates a positive degree of participation. It suggests that the youth in the chosen barangays in Silang, Cavite, are actively engaged in health-related activities linked to self-awareness seminars.

Table 2.3
The Level of Engagement of the Youth in Sports-related Activities

Indicators	Mean Score	Adjectival Meaning	Verbal Interpretation
I am engaged in sports leagues in my community.	3.10	Sometimes	Engaged
I am engaged in board game tournaments in my community.	2.12	Seldom	Slightly Engaged
I am engaged in mobile game tournaments in my community.	2.48	Seldom	Slightly Engaged
I am engaged in sports clinics and workshops in my community.	2.61	Sometimes	Engaged
I am engaged in organizing and volunteering at local sports festivals and competitions in my community.	2.71	Sometimes	Engaged
Total	**2.60**	**Sometimes**	**Engaged**

Table 2.3 shows that statement 1, *"I am engaged in sports leagues in my community,"* got the highest mean score of 3.10 with an adjectival meaning of sometimes and was verbally interpreted as engaged. Youth engagement in sports is accompanied by substantial health, social-emotional, and achievement-linked benefits." Specifically, inquiring about reliably demonstrating

sports support is connected to their progressing physical and mental well-being, scholastic accomplishment, and expanded levels of body regard, certainty, and dominance, with a few signs (Co et al.ett, 2019). On the other hand, statement 3, *"I am engaged in board game tournaments in my community,"* got the lowest mean score of 2.12 with an adjectival meaning of seldom and was verbally interpreted as Slightly Engaged. Research shows frequent casual gamers have lower self-efficacy, potentially influencing or protecting against excessive gaming. Improving psychological well-being through self-efficacy can prevent addiction in young adults (Chung et al., 2020). Overall, the responses of the youth in sports-related activities totaled a mean score of 2.60, which was verbally interpreted as Engaged. The fact that the score is above the midpoint of the scale indicates a positive degree of participation. It suggests that the youth in the chosen barangays in Silang, Cav,ite are actively engaged in sports activities linked to sports leagues.

Table 2.4
The Level of Engagement of the Youth in School-related Activities

Indicators	Mean Score	Adjectival Meaning	Verbal Interpretation
I am engaged in after-class study sessions in my community.	2.38	Seldom	Slightly Engaged
I am engaged in free printing services in my community.	2.67	Sometimes	Engaged
I am engaged in educational assistance in my community.	2.76	Sometimes	Engaged
I am engaged in scholarship programs in my community.	2.60	Sometimes	Engaged
I am engaged in Brigada Eskwela in my community.	2.87	Sometimes	Engaged
Total	**2.66**	**Sometimes**	**Engaged**

Table 2.4 shows that statement 5, *"I am engaged in Brigada Eskwela in my community."* got the highest mean score of 2.87 with an adjectival meaning of sometimes and was verbally interpreted as engaged. Cooperation among many stakeholders in Brigada Eskwela, such as students, parents, teachers, local government entities, and community members, is significant. This inclusive approach encourages youth to take responsibility and ownership of their school environment (DepEd, 2023). On the other hand, statement 1, *"I am engaged in after-class study*

sessions in my community." got the lowest mean score of 2.38 with an adjectival meaning of seldom and was verbally interpreted as slightly engaged. The significance of approaching the issue of student engagement and disengagement as one that requires group action as opposed to one that is personal. To overcome student disengagement, the study highlights the necessity of boundary-bridging mechanisms such as inter-professional teams, school-community partnerships, and cross-sector collaborations (et al.son, 2020). Overall, the responses of the youth in school-related activities totaled a mean score of 2.66, which was verbally interpreted as Engaged. The score above the scale's midpoint indicates a positive degree of participation. It indicates that the youth in the chosen barangays in Silang, Cav,ite are actively engaged in school activities.

Table 2.5
Overall Result

Barangay Activities	Mean Score	Verbal Interpretation
Community Drive-related Activities	2.96	Engaged
Health-related Activities	2.40	Slightly Engaged
Sports-related Activities	2.60	Engaged
School-related Activities	2.15	Slightly Engaged
Total	**2.53**	**Engaged**

Table 2.5 shows that the community drive-related activities got the highest mean score of 2.96 with a verbal interpretation of Engaged. On the other hand, school-related activities got the lowest mean score out of all community-based activities in Silang, Cavite.

V. Discussion

The researchers found out that there's no study regarding the engagement of the youth in community activities in the municipality of Silang, Cavite. In addition, a former Sangguniang Kabataan Official also stated that the youths are not active in the community activities implemented by the officials because of a lack of time and interest. The researchers then aimed to determine the youth's level of engagement in community activities implemented by the SK Officials at their barangays. According to survey results, teenagers in ten selected barangays in Silang, Cavite, are engaged in community activities organized by the Sangguning Kabataan. The

results indicated that the level of youth engagement across community-driven, health-related, sports-related, and school-related activities showed that most youths under 17-18 and females are more likely to engage in the said activities. Among all the activities, the results showed that youth are more engaged in community drive-related activities. Followed by sports-related activities, then health-related activities, and school-related activities.

The researchers' data was limited due to several challenges during the data collection. One significant obstacle was the rejection of some barangays, who were not open to participating in the study. Additionally, the scope of the study was limited because the researchers, being students, could not cover the entire municipality. Out of the 64 barangays, only ten were included in the study. Another challenge arose from the difficulty in gathering data due to the unavailability of respondents. Many respondents were not accessible for surveying, either because they were not open to participating or because they were unavailable during weekdays, as they were attending school. Furthermore, maintaining contact with officials in the barangays proved challenging, as they were the primary point of contact for communication before, during, and after the data-gathering process.

For future researchers to obtain the essential information and approvals for conducting studies, they must prioritize establishing strong communication channels with local officials. To account for respondents' limited availability—particularly for students who could be unavailable on weekdays owing to school obligations—flexible data-gathering procedures should be implemented, utilizing technology to reach the respondents. It is important to take proactive steps to evaluate and resolve safety issues in new and potentially unsafe research environments, prioritizing the well-being of researchers and respondents throughout the research process. Finally, the researchers recommend broadening the scope of the demographical location to know whether youth are engaged in activities in other barangays. Future researchers may also conduct a study on why some youths are not engaged in the implementation of other SK community-based activities.

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Banana Core Chips: An Alternative to Regular Chips

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I. Abstract

Bananas are a major crop in the Philippines. However, only the banana fruits are harvested and sold. The banana core is considered a waste in banana plantations where there is a considerable economic impact after harvesting banana bunches. They are typically cut down and abandoned on the plantation to decompose into organic trash and pollute the environment. Further research and developments in the field of food innovation could lead to the development of healthier and more environmentally friendly snack options using banana cores, such as Banana Core Chips. The researchers used a quasi-experimental design, purposive sampling techniques, and a survey questionnaire. The respondents were senior high school students from Olivarez College Tagaytay. The evaluation focused on the taste, texture, appearance, and aroma of the product. This research outlines the ingredients used in banana core chips as an alternative to regular chips and the step-by-step process for making these chips. The taste, aroma, and appearance of the product were evaluated as highly acceptable. Thus, the overall results of the banana core chips imply that the banana core can be a great alternative to regular chips. The researchers failed to reach all intended target respondents, focusing instead on senior high school students at Olivarez College Tagaytay. Future researchers should explore banana core chips in various sizes, shapes, and flavors, gather data from a larger population, experiment with non-edible banana tree parts, and develop other banana core-based products.

Keywords: *Banana core chips, teenagers, acceptability*

II. Introduction

Bananas are a major crop; the waste of banana cores represents a loss of potential revenue and resources for farmers and producers. Pseudo-stems are used in banana plantations where there is a considerable economic impact after harvesting banana bunches; they are typically cut and abandoned in the plantation to decompose into organic trash and pollute the environment. According to Acevedo et al. (2021), bananas primarily cultivated in tropical regions globally generate a significant issue post-harvest of the banana biomass being discarded as waste. The researchers found out that this kind of unhealthy diet can affect the health of most teenagers, and the innovation of the product came to solve the problem. The banana core typically refers to the central, fibrous portion found in the center of a banana, containing valuable components such as dietary fiber, vitamins, and minerals. According to Dayod and Abat (2018), since ancient times, banana cores have grown naturally throughout the countries in Asia. After the harvest of the banana fruits, stems commonly become waste, but this waste can be more functional and useful since the middle part of the stem is edible. To come up with a great solution, banana cores are used to make innovations to regular chips as a healthier alternative. This is especially important now that students are more knowledgeable about banana cores. The potential gap in the field of banana core chips research is the limited exploration of innovative processing techniques that could enhance their nutritional value, flavor, or shelf life. There will also be a need to explore environmentally friendly and sustainable ways to make banana core chips. Healthy and more environmentally friendly snack options may be developed as a result of additional research and advances in these fields. This research will encompass the examination of various aspects concerning banana core chips, including methods of production, nutritional advantages, consumer preferences, and the overall viability of this innovative snack. It would integrate elements of food processing, nutritional assessment, and consumer surveys to determine the practicality and appeal of banana core chips as a more health-conscious and environmentally sustainable snacking choice. The objective of the researchers is to contribute to a food industry that is both environmentally conscientious and focused on promoting health. According to Subagyo et al. (2020), one of the most popular and practical plants in the world is the banana tree. One is able to utilize almost every part of this plant, including the fruit, leaves, flower bud, trunk, and pseudo-stem. The fiber obtained from the banana plant's pseudo-stem could be useful for a wide range of purposes.

According to Acevedo et al. (2021), after the harvest of banana fruits, almost 60% of banana biomass is left as waste. One type of waste that can be extracted from banana trees after the harvest is the stems where the core is located. The middle part of the banana stem commonly just becomes a waste because most people do not know that a certain part of the banana tree is edible and safe to eat and can also be cooked in many ways.

The purpose of this study is to innovate regular chips and make alternative chips made from the banana core, which is the center part of the banana tree stem, and have them evaluated by senior high school students at Olivarez College Tagaytay.

This study determines the Banana Core is not wasted and can be used to innovate; the study sought to answer the following questions:

1. **What are the ingredients used in Banana Core Chips as an Alternative to Regular Chips?**
2. **What is the process of making Banana Core Chips as an Alternative to Regular Chips?**
3. **What is the level of acceptability of Banana Core Chips as an Alternative to Regular Chips in terms of:**
    - **3.1 Taste**
    - **3.2 Texture**
    - **3.3 Appearance**
    - **3.4 Aroma**

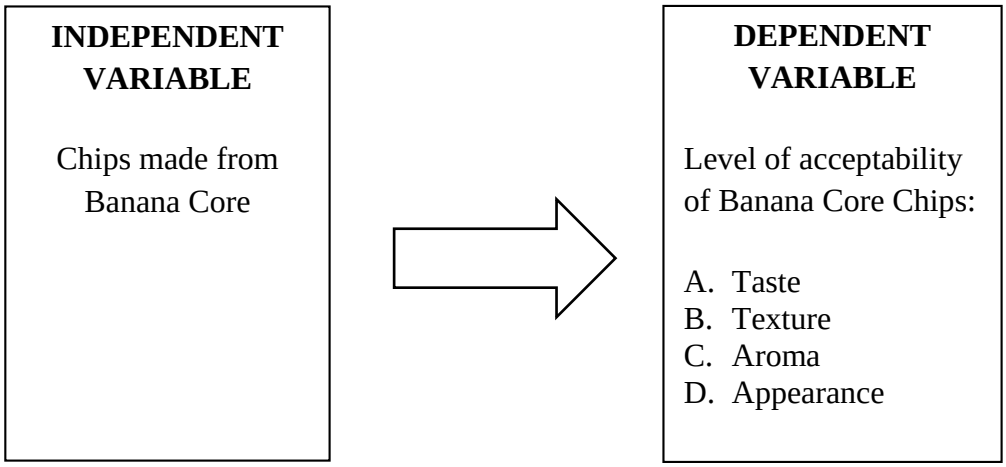
The study holds significant implications for a wide range of individuals, from the students particularly teenagers, who often consume unhealthy snack food choices. It is also significant to the senior high school students at Olivarez College Tagaytay. By shedding light on the innovation and potential benefits of banana core chips, this research will serve as a valuable resource for those teenagers who regularly consume such unhealthy snacks. Since regular chips are well known for being unhealthy yet convenient snacks, the innovation of banana core chips can be beneficial to teenagers because they are a healthier alternative to regular chips.

In the study of Situmorang et al. (2023), they investigated that the unhealthy snacking behavior of students was associated with the food environment along routes to school and around schools. This theory was used to identify the consumption of the students' unhealthy chips around Tagaytay City. This theory is concerned with how the innovation of banana core chips can be

beneficial among students and teenagers since there is a wide variety of stores around Tagaytay City that sell unhealthy chips. As a result, the theory is useful in identifying the benefits of the innovation of banana core chips as a healthier alternative to regular chips that are evaluated among teenagers around certain barangays in Tagaytay City.

Figure 1.

Conceptual Paradigm



In a quasi-experimental setup, the investigator manipulates or assesses independent and dependent variables, but the distribution of participants into groups isn't random. Data are compiled, and the results either validate or challenge the hypothesis. This design is employed to determine whether banana core chips meet the standards in terms of taste, texture, smell, and appearance. The quasi-experimental research models are used to gather the required data, providing a controlled environment for the researchers to test their hypotheses before moving on to clinical trials. The study included the dependent variable, which is the acceptability of banana core chips based on their taste, texture, smell, and appearance, and the independent variable, which is the banana core chips themselves.

III. Methodology

The research design used in this study was quasi-experimental. According to the study of Maciejewski (2018), quasi-experiments share numerous similarities with randomized controlled trials, but they pose significant challenges when it comes to designing and executing them due to potential threats to internal validity stemming from the lack of randomization. The researchers modified and evaluated an independent variable in a quasi-experimental design, but respondents were not assigned to groups at random. The researchers gather data, and the findings either confirm or refute the idea. Researchers employed a design to determine if banana core chips are acceptable in terms of taste, texture, aroma, and appearance.

The researchers conducted a data collection study focusing on the senior high school students at Olivarez College Tagaytay who live around Tagaytay City. The choice of this location was based on its higher population and the assumption that residents, particularly teenagers, may have an interest in chips. According to the 2015 Census Report, there are 16,095 homes and 71,181 people living in Tagaytay overall. The researchers used the purposive sampling method to choose their respondents. Purposive sampling is a sample method in which the researcher selects an individual from the population to take part in the study based on their discretion. According to Campbell et al. (2020), Purposive sampling is used to better match the sample to the objectives and goals of the study, strengthening the study's rigor and the reliability of its data and findings.

The researchers employed a survey questionnaire format. A specific tool referred to as the survey questionnaire is a systematic tool to organize data to reduce errors and accuracy. According to Zivcovic (2023), a matrix question is a sort of closed-ended survey question where respondents are given many alternatives within a single topic. These surveys asked respondents predetermined questions that were frequently presented on a scale. The researchers provide the questions. Researchers found this format to be the most promising method for quickly and efficiently gathering detailed information from participants, so they utilized it to get data from respondents.

The statistical treatment used frequency distribution and percentage in each category or date set. The weighted mean used to convert the respondent's verbal responses in each statement would be used.

First Trial Procedure

The first procedure for the banana core product is to slice the banana core thinly and cut it into bite-size pieces. Second, wash it with salt, soak it for about 20 minutes, then rinse it with water and dry it with a paper towel. Third, combine all the ingredients used in the coating mixture and coat the banana core chips into the coating mixture. Fourth, preheat the pan and put oil; put the banana core chips into the pan, and cook it for 5 minutes in medium heat until golden brown. Lastly, drain the excess oil using a paper towel, cool it down, and put it in sealed packaging. After that, the outcome of our product is the taste is not too flavorful (we need to increase the measurements of the flavoring). It is not too crispy (need to adjust the cooking time and temperature), it is easy to get burned (adjust the temperature), and there are some fibers in the chips (need to slice them more thinly); the last is oil (should be baked or air-fried)

Banana Core Chip Ingredients

Measurements	Amount	Ingredients
1	Cup	All Purpose Flour
1/2	Cup	Cornstarch
4	Teaspoons	Iodized Salt
2	Teaspoons	Powdered Sugar
2	Cups	Vegetable Oil
1	Kilogram	Banana Core Chips

The table shows the ingredients and measurements that the researchers used in this experiment. The researchers spent many days looking for the perfect recipe for making banana core chips, which are a perfect alternative to regular chips.

Second Trial Procedure

To begin making banana core chips, thinly slice the banana core, then chop it into bite-sized pieces. After that, wash it with salt, let it soak for about 20 minutes, rinse it with water, and pat dry with a paper towel. Next, combine ½ cup of all-purpose flour, 1 cup of cornstarch, three teaspoons of iodized salt, and 3 teaspoons of powdered pepper for the coating mixture and dip the banana core chips into it. Additionally, preheat the pan, add the oil, add the banana core chips, and fry for five minutes or until the chips turn golden brown. Lastly, wipe away any leftover oil with a paper towel, allow it to cool, then place it in a tight container and keep it somewhere dry and cool.

Measurements	Amount	Ingredients	Remarks
1	Cup	All-purpose flour	Reduced ½ cup of cornstarch
1/2	Cup	Cornstarch	Added ½ cup of cornstarch
4	Teaspoons	Iodized Salt	Reduced by 1 teaspoon
2	Teaspoons	Powdered Pepper	Added 1 teaspoon of powdered pepper
2	Cups	Vegetable Oil	Maintain
1	Kilogram	Banana Core Chips	Maintain

The table shows the ingredients and measurements that the researchers used in this experiment. The researchers spent many days looking for the perfect recipe for making banana core chips, which are a perfect alternative to regular chips.

The researchers created a requisition letter to the principal asking permission to survey intended respondents. The researcher distributed the self-made survey questionnaires through an online platform, Google Forms, and calculated the results after obtaining responses. The level of acceptability of those who responded was calculated using the average or mean of each indicator.

The researchers calculated the scores and mean ranges for a scale to arrive at a definitive interpretation of the findings.

Researchers tested whether people would take banana core chips in place of other types of chips. First, the researchers made chips from banana cores components based primarily on the banana cores. Next, the researchers conducted an experiment in which researchers tested the acceptability of banana core chips by giving out survey questionnaires to teenagers in a selected barangay in Tagaytay City. The banana core chips were given to the teenagers in Olivarez College Tagaytay who live around Tagaytay City and were chosen using a quota sampling technique. Lastly, after the respondents had tested the banana core chips handed to them, they answered the survey questions given by the researchers. Each of the respondents evaluated the taste, texture, appearance, and aroma of the product.

IV. Results

Problem 1. What are the ingredients used in Banana Core Chips as an alternative to regular chips?

Table 1.

Ingredients and Measurement of the Banana Core Chips

Ingredients	Amount	Measurement
All-purpose flour	1	Cup
Cornstarch	½	Cup
Iodized salt	4	Teaspoon
Powdered pepper	2	Teaspoon
Vegetable oil	2	Cup
Banana core	1	Kilogram

Table 1 shows the ingredients used to make banana core chips. These chips are composed of various ingredients such as all-purpose flour, cornstarch, iodized salt, powdered pepper, vegetable oil, and the banana core, which is the most important component that makes them unique.

Problem 2. What is the process of making Banana Core Chips as an alternative to regular chips?

To begin creating a banana core product, thinly slice the banana core, then chop it into bite-sized pieces. After that, wash it with salt, let it soak for about 20 minutes, rinse it with water, and pat dry with a paper towel. Next, combine all of the ingredients for the coating mixture and dip the banana core chips into it. Additionally, preheat the pan, add the oil, add the banana core chips, and fry for five minutes or until the chips turn golden brown. Lastly, wipe away any leftover oil with a paper towel, allow it to cool, then place it in a tight container and keep it somewhere dry and cool.

Problem 3. What is the level of acceptability of banana core chips as an alternative to regular chips in terms of:

3.1 Taste

3.2 Texture

3.3 Appearance

3.4 Aroma

Table 2.

Acceptability of banana core chips as an alternative to regular chips in terms of taste

Indicators	Weighted mean	Verbal Interpretation
The saltiness of banana core chips.	3.32	Highly Acceptable
The smoky taste of banana core chips.	3	Acceptable
The cheesiness of banana core chips.	3.35	Highly Acceptable
The sweet and sour taste of banana core chips.	3.37	Highly Acceptable
Average	**3.32**	**Highly Acceptable**

Table 4 shows the level of acceptability of Banana core chips as an alternative to regular chips in terms of taste, with an average mean of 3.32, which is interpreted as highly acceptable. The data shows that the indicator *"The sweet and sour taste of Banana Core chips"* attained the highest mean rating of 3.37, which was interpreted as highly acceptable, while the indicator "The Smoky taste of Banana Core Chips" attained the lowest mean rating of 3 which was interpreted as acceptable. According to Allais (2021), it has been demonstrated that wood and charcoal are essential for producing the smokey flavor and aroma, but the flavor of grilled food is also greatly enhanced by glycation events, commonly known as Maillard reactions. Additionally, these give the grilled meat its distinctive brown color.

Table 5.

Acceptability of banana core chips as an alternative to regular chips in terms of texture

Indicators	Weighted Mean	Verbal Interpretation
The flaky texture of banana core chips	3.2	Acceptable
The crunchiness of banana core chips	3.18	Acceptable
The roughness of banana core chips	3.23	Acceptable
Average	**3.21**	**Acceptable**

Table 5 shows the level of acceptability of Banana core chips as an alternative to regular chips in terms of texture, with an average mean of 3.21, which is interpreted as acceptable. The data shows that the indicator *"The roughness of Banana Core Chips"* attained the highest mean rating of 3.2, which is also acceptable, while the indicator *"The flaky texture of Banana Core chips"* attained the lowest mean rating of 3.2, which is interpreted as acceptable. According to Hernandez-Brenez (2022), the specific gravity and starch content of potatoes, in particular, have a significant impact on the quality and characteristics of the final goods, particularly fried potato chips. According to Hernandez-Brenez (2022), the specific gravity and starch content of potatoes, in particular, have a significant impact on the quality, texture, and characteristics of the final goods, particularly fried potato chips.

Table 6.

Acceptability of banana core chips as an alternative to regular chips in terms of appearance

Indicators	Weighted mean	Verbal interpretation
The size of banana core chips	2.99	Acceptable
The shape of banana core chips	3.16	Acceptable
The color of banana core chips	3.50	Highly Acceptable
The crisscross appearance of banana core chips	3.50	Highly Acceptable
Average	**3.29**	**Highly Acceptable**

Table 6 shows the level of acceptability of Banana core chips as an alternative to regular chips in terms of appearance, with an average mean of 3.29, which is interpreted as acceptable. The data shows that the indicator *"The color of Banana Core chips"* and *"The crisscross appearance of Banana Core chips"* attained the highest mean rating of 3.50, which is highly acceptable, while the indicator *"The size of Banana Core Chips"* attained the lowest mean rating of 3.16 which is acceptable. Areeprasert et al. (2017) used two cutting shapes—rectangular and circular—to examine the drying behavior of cassava chips, and the results were evaluated at various air temperatures. According to Oz (2020), here, the levels of food toxicants, namely heterocyclic aromatic amines, and polycyclic aromatic hydrocarbons, were measured in salmon filets that had been smoke-flavored with various smoking wood chips (oak, apple, bourbon-soaked oak, cherry, and hickory), as well as in samples that had been barbecued but weren't smoke-flavored.

Table 7.

Acceptability of banana core chips as an alternative to regular chips in terms of aroma

Indicators	Weighted mean	Verbal interpretation
The cheesy smell of banana core chips	3.24	Acceptable
The banana smell of banana core chips	3.31	Highly Acceptable

Average	**3.28**	**Highly Acceptable**

Table 7 shows the level of acceptability of Banana core chips as an alternative to regular chips in terms of aroma, with a total mean of 3.28, which is interpreted as highly acceptable. The data shows that the indicator *"The banana smell of Banana Core chips"* attained the highest mean rating of 3.31, which is highly acceptable, while the indicator *"The cheesy smell of Banana Core Chips"* attained the lowest mean rating of 3.27 which is also highly acceptable. According to Fujioka (2021), cheese aroma is known to affect consumer preference. The purpose of the study was to look into the association between cheese aroma e-nose levels and sensory evaluation scores.

Table 8.

Acceptability of banana core chips as an alternative to regular chip

Indicators	Mean	Interpretation
Taste	3.32	Highly Acceptable
Texture	3.21	Acceptable
Appearance	3.29	Highly Acceptable
Aroma	3.28	Highly Acceptable
Average	**3.27**	**Highly Acceptable**

Table 8 shows the acceptability of Banana core chips as an alternative to regular chips, with an average mean of 3.27, which is interpreted as highly acceptable. The data shows that the taste of banana core chips attained the highest mean rating of 3.32, which was interpreted as highly acceptable, while the texture of banana core chips attained the lowest mean rating of 3.21, which was interpreted as acceptable.

V. Discussion

The purpose of the current study was to innovate the traditional chips and determine the overall acceptability of Banana Core Chips as an alternative to regular chips. The results showed that in terms of texture, the chips are acceptable. In terms of taste, appearance, and aroma, the

chips are highly acceptable. Overall, the Banana Core Chips were evaluated as Highly Acceptable. The experiments confirmed that Banana core chips are a great alternative to regular chips.

The researchers did not reach the intended target respondents for the data gathering. The researchers intended to roam around several chosen Barangays in Tagaytay City to gather the necessary data to determine how acceptable banana core chips are among teenagers as an alternative to regular chips. However, due to unavoidable circumstances, the researchers opted to gather data from Olivarez College Tagaytay students who lived around the area of Tagaytay City.

For more in-depth research on the topic, future researchers can create banana core chips in different sizes, shapes, and flavors. Future researchers can also gather data from a larger population to get much more reliable and diverse results when it comes to the acceptability of the product. Other parts of the banana tree that are also not well known to be edible can also be experimented with to make chips by future researchers. And lastly, future researchers can create other products made from banana core.

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Olivarian Hymn

To you dear Olivarez College
Faithful children we will be
With the golden hearts to last forever
We vow for eternity

REFRAIN
To the gold, red and green
We pledge our loyalty
Our light, our guide and our hope
Olivarez College

Our knowledge will last forever
To serve humanity
The Christian teachings given us
Shall forever be in our hearts

(Repeat REFRAIN twice)

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