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Camp Vicente Lim Integrated School

SALIKSIK

Limian's Senior High School Research and Innovation Journal

Structured **A**nalyzing and **L**earning through **I**n-depth **K**nowledge, **S**canning, and **I**nterdisciplinary **K**nowledge

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Harnessing the power of structured analysis and shared knowledge to shape a future driven by research, innovation, and excellence.

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Website: www.myeduheart.com
Mobile Number: +63 9524800719

and

CAMP VICENTE LIM INTEGRATED SCHOOL
Mayapa, Calamba, Philippines, 4028
Phone No.: +63 (049) 530 2090
email: 301516@deped.gov.ph
fb page: https://www.facebook.com/CVLIS2022

ABOUT THE JOURNAL

SALIKSIK: Limian's Senior High School Research and Innovation Journal
Volume 1 Issue No. 1

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SALIKSIK: Limian's Senior High School Research and Innovation Journal is a peer-reviewed academic journal dedicated to advancing scholarly research and promoting intellectual discourse across diverse disciplines. The journal serves as a platform for researchers, educators, and professionals to publish high-quality, original works that advance knowledge and drive innovation.

Guided by its core principle of **structured analysis and in-depth learning**, SALIKSIK encourages rigorous research methodologies, critical thinking, and evidence-based studies that address contemporary issues in both local and global contexts.

Scope and Coverage

The journal welcomes multidisciplinary contributions in areas including, but not limited to:

- Accountancy, Business, and Management
- Humanities and Social Sciences
- Science, Technology, Engineering, and Mathematics
- Home Economics
- Information and Communications Technology
- Industrial Arts

Editorial and Review Process

All submissions undergo a **double-blind peer review process** to ensure academic integrity, originality, and relevance. The journal is committed to maintaining high editorial standards and ethical publishing practices.

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- Original Research Articles
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2. Scope of the Journal

The journal accepts multidisciplinary research in areas including, but not limited to:

- Accountancy
- Social Sciences
- Business and Management
- Science and Technology
- Engineering
- Mathematics
- Humanities
- Home Economics
- Information and Communications Technology
- Industrial Arts

3. Types of Manuscripts

The journal publishes:

- Original Research Articles
- Review Articles
- Case Studies
- Conceptual / Theoretical Papers
- Action Research
- Conference Papers / Proceedings

4. Manuscript Preparation

4.1 Structure (IMRAD Format)

Manuscripts should be organized as follows:

- **Title Page** (Title, Author(s), Affiliation, Email)
- **Abstract** (150–250 words)
- **Keywords** (3–5 keywords)
- **Introduction**
- **Methodology**
- **Results**
- **Discussion**
- **Conclusion**
- **References**

4.2 Formatting Requirements

- Font: Times New Roman, Size 12
- Spacing: Double-spaced
- Margins: 1 inch (all sides)
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- Initial editorial screening
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- No simultaneous submissions
- Proper citation and acknowledgment
- No plagiarism, fabrication, or falsification

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- Authors must sign the required declaration form
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- Initial Screening: 3–7 days
- Peer Review: 2–4 weeks
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11. Submission Process

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✅ Submission Checklist

Before submitting, ensure that:

✓ Manuscript follows IMRAD format
✓ References are in APA format
✓ Plagiarism check is completed
✓ Required forms are signed
✓ All author details are complete

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TERNATURAL BLUEM SIP AND BITES

Authors: Axel Neo B. Alcasid, Bea Bettina T. Balido, John Cedric E. Borero, Kaye C. Cabague, Angel R. Caicten, Arianne Faye O. Conda, Jan Florimar, Jefferson S. Haresco, Princess Jemica M. Mico, Jeff Mico Molenilla, Beatriz N. Quito, Pauline Kate E. Vial
School Year 2025-2026

Research Adviser: Virginia V. Papas

ABSTRACT

Market demand analysis, supply analysis, pricing strategy, and financial analysis are all considered in this feasibility study, which examines the viability of Ternatural Purple Bluem, a company that focuses on producing bread and drinks infused with herbal flowers such as blue Clitoria ternatea, also known as the "butterfly pea" and "blue ternate flower." Based on the survey conducted among the pupils of Camp Vicente Lim Integrated School, there is a substantial demand for locally flavored products, making the company's market potential viable.

With an income statement showing a net profit of P6,789.67 for January 2026, the financial analysis indicated profitability. Production and operational strategies were created to ensure efficiency. However, the income statement included labor wages, highlighting the need for effective marketing methods and a slight price adjustment to boost sales. The study found that Ternatural Purple Bluem is a promising business opportunity. It was innovated by using herbal flowers to make pastries and beverages instead of herbal supplement capsules, syrup, and tablets, resulting in a unique and profitable product.

KEYWORDS: *herbal, market potential, unique innovation, pastry, beverages*

ACKNOWLEDGMENT

The researchers express their sincere gratitude to **Ms. Mildred M. De Leon**, school principal, for granting permission to conduct this feasibility study within the school premises. Special thanks are extended to **Mrs. Virginia V. Papas** for her guidance, support, and valuable insights in the development of *Ternatural Bluem Sip & Bites*. Appreciation is also given to **Mrs. Almabeth B. Domino** for allowing the use of laboratory equipment and for assisting in the cooking laboratory and to **Mr. Patrick R. Nahial** for guidance in preparing the financial reports

and income statement. The researchers likewise thank **Mr. Earl G. Beruela** for his constructive suggestions, **Mr. Kenneth P. Alcantara** for his support in workplace management, and **Mr. Jay Rick T. Escobar II** for improving the manuscript's grammar. Gratitude is extended to the teachers, students, and **ABM Confucius of Camp Vicente Lim Integrated School** for their cooperation and support. Above all, the researchers thank **Almighty God** for His blessings and their **families and friends** for their constant encouragement and support.

I. INTRODUCTION

The blue Clitoria ternate flower can be called the butterfly pea flower for its appearance. This flower is not just appealing for its color but also for its health benefits. The color of its flower is called "teratins," which is a natural pigment that gives vibrant color while acting as antioxidants that protect the body from harmful free radicals. Because of this, it is now being used to make food and drinks both healthier and more visually appealing (Oguis et al., 2019).

The proposed products in this study are simple yet innovative treats: bread made with butterfly pea flower (Clitoria ternatea), filled with delicious ingredients such as sweet potato, ube, and chocolate, and a refreshing drink infused with lemon and butterfly pea flower. These products are not only flavorful but also carry health benefits. The butterfly pea flower has been recognized for its natural properties that may help fight inflammation, obesity, and harmful microbes. Rich in anthocyanins, it also helps the body reduce oxidative stress, making it a nutritious and functional ingredient that adds both color and wellness to everyday food.

In addition to bread, herbal drinks have been explored for their health-promoting properties. Butterfly pea flower combined with lemon is particularly notable because it contains flavonoids and anthocyanins with potential anti-obesity effects.

According to Anugrahani et al. (2025), a herbal drink for obesity management was developed and evaluated for acceptability, microbiological safety, nutritional content, and phytochemical profile. The study found that such beverages can be both functional and appealing to consumers, as confirmed by organoleptic testing.

Herbal foods are commonly consumed as capsules, tablets, or juice. This study explores their incorporation into pastries, specifically bread, allowing consumers to enjoy a familiar snack while still gaining health benefits. Previous research has shown that adding functional plant-based ingredients to bread can enhance its nutritional value without compromising sensory qualities. The study by Fatima et al. (2023) reported that incorporating 5% malunggay leaf powder into bread significantly improved its nutritional profile while maintaining acceptable taste, texture, and aroma. This supports the idea that bread fortified with natural ingredients, like butterfly pea flower, can be a practical way to promote healthier food options.

Food plays a big part in keeping us healthy, especially in preventing diseases that are becoming more common worldwide. For teenagers, the eating habits they develop now can have a lasting effect on their health. Choosing healthy foods at a young age not only helps them stay active and energized today but also lowers their chances of developing heart disease and other serious illnesses as they grow older.

Nowadays, finding budget-friendly yet nutritious meals is no longer an issue, as combo meals are not only offered by restaurants and fast-food chains but also available in school canteens and cafeterias. These establishments offer a variety of combo meal options, such as a simple steak paired with a common side dish, soup, and dessert, which can be both creative and appealing for students.

Combo meals in the modern food business have become an important tool for increasing sales. Many fast-food companies in Chandigarh have succeeded by pairing their products at affordable prices with other hot-selling products. Modern fast-food chains and restaurants are trendsetters that have introduced value-based combos by offering customers a range of choices.

Vision Statement

To become the leading provider of vibrant and health-focused blue ternate-infused bread and drinks, bringing natural wellness and color to every Filipino home starting from the classrooms of Camp Vicente Lim Integrated School and expanding across Calamba and beyond." The Blue Ternate Bread and Drinks aspire to be the top choice for unique and nutritious products made with blue ternate flowers in the Philippines. The company envisions establishing itself as a symbol of natural innovation, wellness, and local ingredient pride.

Mission Statement

To provide refreshing and nourishing blue ternate-infused bread and drinks that inspire healthy living and celebrate local flavors. This company is committed to using natural, locally grown ingredients to create delightful products that uplift the body, brighten the day, and support Filipino farmers and communities.

Core Values

These core values represent the guiding principles and beliefs that the enterprise holds important. This reflects the company's commitment to providing balanced, nourishing, and innovative products while supporting local communities and respecting the environment.

B – Balance. The enterprise upholds the harmony between flavor and nourishment by offering wholesome yet gratifying butterfly pea-inspired snacks and beverages, thoughtfully crafted for individuals of all ages.

L – Local Pride. The business takes pride in using homegrown ingredients like blue ternate and aims to support Filipino farmers and help local communities grow.

U – Uniqueness. By creating unique food and beverage options that demonstrate blue ternate's adaptability, the company will promise creativity and originality.

E – Earthy. By using natural and local source ingredients that support local farmers and respect the environment.

Objectives

This working Project Feasibility Study (PFS) is intended to evaluate the feasibility of selling "YakiYume." Specifically, it aimed to evaluate and analyze the following areas:

1. The Technical Aspect of the Study

- Product Description
- Product Process
- Equipment/Materials
- Plant Allocation
- Plant Layout

2. The Marketing Aspect of the Study

- General Business Conditions
- Competitive Condition
- Target Market
- Demand
- Product
- Pricing Strategy
- Promotion
- Packaging

3. The Financing Aspect of the Study

- Capitalization
- Source of Funds
- Total Sales
- Total Expenses
- Income Statement (5 years projected)
- Balance Sheet (5 years projected)
- Cash Flows Statement (5 years projected)
- Return On Investment
- Ratio Analysis

4. The Management Aspect of the Study

- Form of Ownership
- Structure

- Job Analysis
- Company Analysis

5. The Socioeconomic Aspect of the Study

- Contribution to the Government
- Contribution to the Society

II. METHODOLOGY

Ternatural Bluem Sip and Bites determined the sample size required for the market using the Raosoft Sample Size Calculator. There are 4071 students in grades seven (7) through twelve (12) make up the entire population. The researchers provided the Raosoft calculator with certain inputs, including the predicted response rate (50%), the margin of error (5%), and the confidence level (95%). The sample size collected for this case is 352 respondents. The selected sample size enables Ternatural Bluem Sip and Bites to obtain essential and significant market insights across grade levels and use the information gathered to inform decision-making in conducting this working Project Feasibility Study (PFS).

III. RESULT

This section presents the financial aspect of the business and evaluates its viability and sustainability. Prior to actual operations, a 10-day business simulation was conducted to gather financial data, which served as the basis for projections ranging from 1 to 5 years. Included in this portion are the estimated projected costs, projected income statement, and relevant financial ratios derived from the simulation results. These are used to assess the business's profitability, financial stability, and ability to provide reasonable returns to the partners.

Table 1. Average Net Income per Day

Particulars	Total	Averages
SALES		
Kamote Bites	₱ 2,700.00	₱ 270.00
Ube Bites	8,820.00	882.00
Choco Bites	10,740.00	1,074.00
Bluem Juice	4,176.00	417.60
Add Ons	40.00	4.00
Combo juice+bread	690.00	69.00
Combo 3pcs	2,415.00	241.50
NET SALES	**₱ 29,581.00**	**₱ 2,958.10**
Less: Cost of Goods Sold	7,927.68	792.77
GROSS PROFIT	**₱ 21,653.32**	**₱ 2,165.33**
Less: Operating Expenses		
Supplies Expense	1,571.65	157.17
Utilities Expense	300.00	30.00
Transportation Expense	192.00	19.20
Salaries Expense	10,800.00	1,080.00
Rent Expense	2,000.00	200.00
Total Operating Expense	14,863.65	1,299.20
NET INCOME	**₱ 6,789.67**	**₱ 866.13**

The table shows the totals and averages with profit and expenses for the period of January 14-29, 2026. The business posted total net sales of ₱29,581.00, with an average daily sales amount of ₱2,958.10, driven mainly by strong sales of Choco Bites and Ube Bites. The cost of goods sold totaled ₱7,927.68, resulting in a gross profit of ₱21,653.32, or ₱2,165.33 per day. Operating expenses totaled ₱14,863.65, with salaries and rent accounting for the largest share. The business realized a total net income of ₱6,789.67, equivalent to an average of ₱866.13 per day, demonstrating consistent daily profitability.

Table 2. Return on Investment

Year	Net Income	Project Cost	ROI %
1	204,340.34	48,365.10	422.50
2	214,557.36	48,365.10	443.62
3	225,285.22	48,365.10	465.80
4	236,549.49	48,365.10	489.09
5	248,376.96	48,365.10	513.55

The table shows the return on investment for Ternatural PurpleBluem over five years. The net income per year will be: 204,340.34 (Year 1), 214,557.36 (Year 2), 225,285.22 (Year 3), 236,549.49 (Year 4), and 248,376.97 (Year 5), with a projected cost of 48,365.10 per year. In five years, the Return On Investment (ROI) per year will be 422.50% (Year 1), 443.62% (Year 2), 465.80% (Year 3), 489.09% (Year 4), and 513.55% (Year 5).

Table 3. Payback Period

Year	Cash Sales	Capital Recovery	Payback Period in Years
1	204,340.34	48,365.10	0.24
2	214,557.36		
3	225,285.22		
4	236,549.49		
5	248,376.96		
Total Payback Period (in years)		48,365.10	**0.24**

This table shows that the business recovers its initial investment within 0.24 years (approximately 3 months). This very short payback period indicates quick capital recovery, low risk, and strong potential for profitability in the succeeding years.

IV. DISCUSSION

Results indicate that the business venture Ternatural PurpleBluem has the potential to succeed in the school setting. It has little to no competition, high student interest, and affordable prices. The product offerings and spending habits of the 352 students who participated in the market survey. The supply aspect of the competitors was also studied through surveys and interviews. The aspects studied included the competitors' physical layout, equipment used, manpower required, production processes, ingredients used, and quality control processes. The financial aspect covered income statements, profitability estimates, and expected expenses. Data

analysis was done to determine the supply, demand, and revenue estimates. Bluem Bites and Bluem Juice provide a nutritious food option for the students with a distinctive taste. With proper planning and effective marketing strategies, problems such as students' aversion to kamote fillings and price rivalry with other brands can be overcome. Ternatural PurpleBluem is a competent business venture that will give the students a delicious and nutritious treat while providing the researchers with valuable experience in the field of business.

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Limian's Senior High School Research and Innovation Journal
Structured Analyzing and Learning through In-depth Knowledge, Scanning, and Interdisciplinary Knowledge

YAKIYUME: CRABSTICK AND CHEESE TAKOYAKI WITH TERIYAKI DRIZZLE AND MIDORI DRINK

Authors: Kristian Fern D. Antiquerra, Nicole R. Tobias, Hazel Joice M. Carag, Justine B. Dignos, Ashley C. Parian, Jim Cyrus E. Tayoto, Noeme R. Estacio, Mariel D. De Mesa, Lea M. Mirabel, Niel Andrew Ritcher S. Tinasas, Audrey Mhadel P. Dela Cruz
School Year 2025-2026
Research Adviser: Virginia V. Papas

ABSTRACT

This study examined the feasibility of YakiYume, a food-and-snack business offering an innovative Takoyaki experience. The menu includes Crabstick, Cheesy Mushroom, and Veggie Tofu flavors, catering to diverse tastes, paired with Midori Drink, a refreshing blend of lemon, nata de coco, and cucumber. The study involved thorough planning, including trial-and-error product testing, demand and supply analysis, pricing strategy development, marketing strategies, and financial projections. A survey conducted among students at Camp Vicente Lim Integrated School revealed a strong preference for Japanese-inspired products and healthy drinks, highlighting the business's promising market potential. Efficient production and operational strategies were applied, and financial analysis indicated profitability, with the January 2026 income statement showing a net profit of ₱20,468.37. The study concludes that YakiYume is a viable business opportunity, offering innovative and healthy options while delivering a unique and highly profitable product.

KEYWORDS: *YakiYume, Takoyaki, Midori Drink, Japanese-inspired products, financial analysis, profitability*

ACKNOWLEDGMENT

The researchers sincerely thank their research adviser, **Mrs. Virginia V. Papas**, for her guidance and support throughout the study; their class adviser, **Mr. Earl Beruela**; their business simulation teacher, **Mr. Kennett P. Alcantara**; and the panelists, language editor, and teachers who contributed their expertise and resources toward improving the research. Appreciation is also extended to the **school principal, the ABM Dewey researchers, faculty, students, and staff of Camp Vicente Lim Integrated School** for their cooperation. The researchers are equally grateful

to their **families and friends** for their unwavering support. Above all, they thank **Almighty God** for the wisdom and blessings that made this study possible.

I. INTRODUCTION

Globally, Japanese cuisine has gained immense popularity, with Takoyaki standing out as a well-loved street food for its flavorful batter, savory fillings, and variety of toppings. This trend has influenced many countries, including the Philippines, where Japanese-inspired food businesses continue to expand. Nationally, Filipino consumers have embraced Takoyaki not only for its taste but also for its versatility, allowing for localized flavors that suit diverse palates.

The food industry in the Philippines has experienced consistent growth over the past decade, especially in the street food sector, which remains popular due to its affordability, accessibility, and variety. Takoyaki, a Japanese wheat-batter snack often filled with diced octopus, has become a mainstream Filipino favorite. According to Business Diary (2021), the Takoyaki food cart business has become a hot trend in the Philippines, with demand surging among students, professionals, and mallgoers due to its flavorful taste and visual appeal. YakiYume builds on this by offering innovative Filipino-inspired variants such as crabstick and cheese and mushroom Takoyaki, aiming to harness this trend with a local twist.

Filipino consumers are also becoming more health-conscious. A 2025 PwC Philippines 'Voice of the Consumer' report notes that 67% of respondents consider nutritional value a significant factor when purchasing food, even more than taste (18%). Over 80% of wearables are for exercise, and 44% use them for dieting, signaling that health and wellness shape consumer decisions. YakiYume responds by pairing its Takoyaki with Midori, a refreshing lemon-cucumber drink that aligns with the growing preference for wellness-supporting food and beverages.

Locally, YakiYume reimagines Takoyaki by blending Japanese culinary techniques with Filipino tastes. Its signature variant features a crab stick and cheese filling topped with a sweet-salty honey-teriyaki glaze, paired with Midori, a lemon-cucumber-nata drink that balances the richness of the dish. This fusion of flavors, cultural influence, and affordability aims to attract a wide market seeking both novelty and familiarity.

Vision Statement

The vision of this research is to create a new small food enterprise that aspires to become the leading seller of traditional Japanese cuisine. The business offers a traditional Japanese-inspired snack alongside Midori Drink, a refreshing drink. This venture aims to incorporate nutrition, unique tastes, and culinary creativity into daily life. YakiYume is available in four unique varieties. The owner intends to offer a healthier snack option for students and teachers at Camp Vicente Lim Integrated School. The ambition for this business

is to gain recognition as an innovative small enterprise and a significant advocate for healthier food and beverage options within the school community.

Mission Statement

The business explores the missions and products of two emerging food innovations: YakiYume and Midori drinks. YakiYume is a type of Takoyaki that focuses on delivering the authentic taste of Japanese street food through high-quality Takoyaki made with healthy ingredients and traditional methods. The company emphasizes creating memorable and communal dining experiences that foster warmth and connection. Meanwhile, Midori Drink introduces a modern twist on a classic refreshment by combining cucumbers with natural honey. It aims to promote a healthier lifestyle through innovative, sustainable, and flavorful offerings. Both products share a commitment to quality, consumer satisfaction, and cultural authenticity, positioning themselves as meaningful contributors to culinary innovation and community well-being.

Core Values

The research is founded upon core values that uphold integrity, objectivity, and scholarly excellence. These guiding principles ensure that the study is conducted ethically, analyzed rigorously, and communicated responsibly. By adhering to these values, the researcher aims to produce findings that are not only credible and meaningful but also advance knowledge and support informed decision-making within the field.

Y - Youthfulness. The business aimed to provide customers with positive perspectives on life and to promote its products.

A - Accountability. The business showed that everyone in the company is expected to take ownership of their work and results.

K - Kindness. The business showed respect to every customer and treated them the same way one treats oneself.

I - Innovation. The business encouraged creativity and staying ahead of competitors.

Y - Yearning. The business expressed a strong desire to learn, grow, and improve everything the researcher does in the company's daily operations.

U - Unity. The business unites as one team to serve the company's products to the potential customers.

M - Motivation. The goal of the business is to inspire and help each customer achieve their goals.

E - Efficiency. The business focused on getting things done effectively with minimal waste.

Objectives

This feasibility study is intended to evaluate the feasibility of selling "YakiYume." Specifically, it aimed to evaluate and analyze the following areas:

1. The Technical Aspect of the Study

- Product Description
- Product Process
- Equipment/Materials
- Plant Allocation
- Plant Layout

2. The Marketing Aspect of the Study

- General Business Conditions
- Competitive Condition
- Target Market
- Demand
- Product
- Pricing Strategy
- Promotion
- Packaging

3. The Financing Aspect of the Study

- Capitalization
- Source of Funds
- Total Sales
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- Income Statement (5 years projected)
- Balance Sheet (5 years projected)
- Cash Flows Statement (5 years projected)
- Return On Investment
- Ratio Analysis

4. The Management Aspect of the Study

- Form of Ownership
- Structure
- Job Analysis
- Company Analysis

5. The Socioeconomic Aspect of the Study

- Contribution to the Government
- Contribution to the Society

II. METHODOLOGY

The study gathered data through surveys conducted at Camp Vicente Lim Integrated School, targeting junior and senior high school students. The survey examined factors affecting demand, including snack preferences, spending habits, and willingness to try new food products.

A total of 352 respondents were selected using the Raosoft Sample Size Calculator, and the data collected were analyzed to determine product acceptability. A supply analysis was also conducted to evaluate competitors, their pricing strategies, and customer base, along with a SWOT analysis to assess business potential.

Additionally, production processes, raw material sourcing, and cost structures were reviewed to ensure efficient operations. Marketing strategies such as social media promotion and promotional offers were also assessed to enhance brand visibility and attract customers.

III. RESULT

A significant 80.4% of respondents expressed willingness to purchase Takoyaki, while an even higher 82.7% showed interest in buying the Midori Drink. These results indicate strong consumer demand and high product acceptability among the target market. These results demonstrate that the business has strong potential for sales and profitability, as most respondents showed clear interest in purchasing both products.

Table 1. Average Net Income per Day

YakiYume
AVERAGE NET INCOME PER DAY
January 14 - 29, 2026

Particulars	Total	Averages
SALES		
Takoyaki	₱ 30,199.00	₱ 3,019.90
Midori Drink	5,190.00	519.00
Combo Meal	8,650.00	865.00
Add-ons	136.00	13.60
NET SALES	**₱ 44,175.00**	**₱ 4,417.50**
Less: Cost of Goods Sold	12,869.76	1,286.98
GROSS PROFIT	**₱ 31,305.24**	**₱ 3,130.52**
Less: Operating Expenses		
Supplies Expense	2,006.87	200.69
Transportation Expense	630.00	63.00
Salaries Expense	5,400.00	540.00
Rent Expense	2,000.00	200.00
Utilities Expense	800.00	80.00
Total Operating Expense	**10,836.87**	**820.00**
NET INCOME	**20,468.37**	**2,310.52**

Financial projections showed that in January 2026, the business earned ₱44,175.00 in sales and had a net income of ₱20,468.37 after all expenses were deducted. This indicates effective cost management and a high profit. The results show that the business is capable of sustaining operations and achieving financial growth.

Table 2. Return on Investment

Year	Net Income	Project Cost	ROI %
1	443,620.61	57,994.65	764.93
2	465,801.64	57,994.65	803.18
3	489,091.72	57,994.65	843.34
4	513,546.31	57,994.65	885.51
5	539,223.62	57,994.65	929.78

The table highlights the projected return on investment over five years. The Return of Investment (ROI) exceeds 700% annually, starting at 764.93 in the first year and reaching 929.78 in the fifth year. It illustrates that the business has strong earning potential and is expected to provide significant returns compared to the initial project cost.

Table 3. Payback Period

Year	Cash Sales	Capital Recovery	Payback Period In Years
1	443,620.61	57,994.65	0.13
2	465,801.64		
3	489,091.72		
4	513,546.31		
5	539,223.62		
Total Payback Period (in years)		57,994.65	**0.13**

The table illustrates how quickly the initial investment can be recovered. Based on projected cash sales, the total project cost is expected to be paid within approximately 0.13 years or less than one year.

Based on the computed data, it implies that high profitability can be achieved with proper strategic planning, efficient labor management, and careful cost control. By maintaining these practices, YakiYume can maximize earnings and sustain long-term success, demonstrating the business's strong potential for growth within its target market.

IV. DISCUSSION

The findings show that the business has strong potential to grow and succeed within the school community because of high demand for affordable, flavorful, and healthy food options. The business is well-received by students, highlighting its appeal as a Japanese-inspired snack and healthy drink that offers a refreshing contrast to the rich flavors of takoyaki, which is both familiar and satisfying. The savory fillings, special sauce, appealing presentation, and healthy snacks help make the products popular. Offering different healthy variants, such as Crabstick and Cheese, Cheesy Mushrooms, and Veggie Tofu, also increases student interest and encourages repeat purchases, which supports the high profitability seen in the financial projections. The observed profitability indicates that, with proper management strategies such as maintaining consistent product quality, controlling costs, and using targeted marketing, it can continue to operate successfully and achieve further financial growth. Overall, YakiYume is an innovative opportunity for young entrepreneurs, combining creativity and strategic planning to keep students satisfied while supporting the business's growth. This study demonstrates that health-conscious, culturally adapted food ventures can thrive in school communities, offering both customer satisfaction and profitable opportunities for aspiring entrepreneurs.

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INFLUENCE OF LIMIANS' EDUCATION ON COLLEGE AND CAREER SUCCESS: A TRACER STUDY OF SENIOR HIGH SCHOOL GRADUATES AT CAMP VICENTE LIM INTEGRATED SCHOOL

Author/s: Lyca P. Broqueza, Jomelyn A. Dela Cruz, Kyla Mae M. Doctora, Angel F. Doctora, Jeremiah P. Ferrancullo, Julius Benidict P. Oclima, Janen Anne O. Oguis, Aaron Shawn C. Salvador, Irich H. Vargas
School Year 2025-2026
Research Adviser: Jay Rick T. Escobar II

ABSTRACT

This study examined the influence of Camp Vicente Lim Integrated School's (CVLIS) Senior High School program on the academic and professional outcomes of its graduates. Using a tracer study methodology and descriptive research design, data were collected through an online structured survey from graduates of the 2018 and 2019 batches. The survey assessed graduates' satisfaction with school programs and services, the skills acquired during senior high school, and their preparedness for college and employment. Results showed that while some graduates pursued vocational training or entered the workforce, the majority continued their education in college. Findings highlighted that the CVLIS program significantly contributed to the development of essential skills, including communication, problem-solving, critical thinking, information literacy, and values formation, which proved beneficial in both academic and professional contexts. Overall, the study concluded that CVLIS education enhanced graduates' readiness for higher education and career opportunities. These insights may inform curriculum improvements and provide guidance for future CVLIS students.

KEYWORDS: *Senior High School, Tracer Study, College and Career Success, Skills Development, Graduate Satisfaction*

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I. INTRODUCTION

Senior high school education is highly valued worldwide for its many benefits. Students can attain their virtues and the pinnacle of their character as they delve into its intervention. According to UNICEF (2021), the implementation of senior high school helped students be certain about the opportunities they would pursue in the future. On the other hand, from the perspective of labor, considering the school and educational system, specifically the senior high school program, it can be perceived that the SHS program increased the employability and career readiness of graduates, as manifested in the countries implementing this system.

While the rationale behind the senior high school (SHS) program in the Philippines is to equip students with the skills needed to achieve high employment rates, actual employment outcomes remain below expectations. Despite 93% of senior high school graduates possessing competencies that align with industry requirements, "only 20% of the top 70 companies in the Philippines are hiring SHS graduates" (DepEd, 2018). Additionally, data from the Bureau of Curriculum Development's (BCD) National Senior High School Tracer Study revealed that the majority of SHS graduates (82.6%) are inclined to pursue higher education rather than enter the workforce.

Given that Camp Vicente Lim Integrated School was established in 2017, the school has not conducted any tracer study to assess the effectiveness of the Limians' education. By conducting a tracer study, the researchers can clarify this anticipation about how Camp Vicente Lim Integrated School is handling the SHS curriculum and determine whether it has fully

realized its mission or vision. This study aims to understand how education in CVLIS shaped the students' success and achievements.

Statement of the Problem

This research investigated the influence of Limians' education on the college and career success of senior high school students' batch 2018–2019 at Camp Vicente Lim Integrated School. It analyzed the extent of correlation between various SHS programs and graduates' development, as well as the level of students' satisfaction with the CVLIS' external factor. By examining this relationship, the study seeks to assess the effectiveness, adequacy, and relevance of CVLIS's articulated SHS program.

Specifically, it sought to answer the following:

1. What is the profile of graduates in terms of:
   1.1. College program articulation, and
   1.2 Course alignment?
2. What is the level of student satisfaction with CVLIS' external factors?
3. To what extent did the various SHS programs contribute to the development of graduates in terms of:
   3.1. Communication skills.
   3.2. Problem-solving skills,
   3.3. Information literacy,
   3.4. Critical thinking skills, and
   3.5. Values formation?
4. Based on the study's results, what is the degree of effectiveness, adequacy, and relevance of CVLIS's articulated SHS program?

Scope and Limitation

This study examined how the education of Limians from Camp Vicente Lim Integrated School affected their success in college and careers. It focused on senior high school graduates from batches 2018 and 2019, including those who pursued college and those who are already working. The study checked how their strand or track, the school's curriculum, and the facilities they used in SHS helped them in their studies and jobs. This study only covered SHS graduates of Camp Vicente Lim Integrated School from Batches 2018 and 2019. Graduates from other schools or other years were not included. The information came from surveys and questionnaires, so the results were based on the graduates' own experiences and opinions.

II. METHODOLOGY

Research Design

The research design used for this study was descriptive. This approach provided an opportunity to analyze several outcomes, such as college admission rates and career achievements, that offered clues about the applicability of the Limians' system of education in real life. In the study by Maderazo (2016), the Tracer Study of Dentistry Graduates of one Higher Education Institution in the Philippines from 2008 to 2012 also used a descriptive research design to describe graduates' experiences before and after employment.

Population and Sampling

The population for S.Y. 2017–2018 was 422, and for S.Y. 2018–2019 was 698, for a total of 1,120. The researchers used purposive-quota sampling to select respondents. In this study, 88 of the 1,120 senior high school (SHS) graduates from Camp Vicente Lim Integrated School who completed the 2018–2019 program participated.

Research Instrument

The study used a structured survey questionnaire to examine the relationship between SHS strands at CVLIS and graduates' college programs or careers, their satisfaction with CVLIS education and services, and the impact of SHS on their success. The questionnaire included closed-ended questions (Likert scale, multiple-choice, and yes/no) on graduate profile (strand completed, current program/employment, and course alignment); satisfaction with CVLIS external factors; and skill development (communication, problem-solving, critical thinking, and values formation) (Catamin et al., 2024).

Statistical Treatment of Data

Data were analyzed using frequency and percentage distribution, where frequency indicated how often a response occurred and percentage showed its proportion of the total (Smith, 2024; Brown, 2024). The mean was calculated by summing graduates' satisfaction scores for CVLIS external factors and skill development across SHS strands, then dividing by the number of respondents (Purdue Online Writing Lab, n.d.). Standard deviation assessed variation in responses relative to the mean (Omda et al., 2023).

III. Result

This section presents the collected data and its corresponding statistical analysis and interpretation.

Table 1. Profile of the Graduates in Terms of Program Articulation

Strand	**f**	**RF**
STEM	14	15.91
ABM	13	14.77
HUMSS	16	18.18
Tech-VOC	36	40.91
GAS	9	10.23
Total	**88**	**100**

The table presents the largest group of respondents belonging to the Tech-VOC strand, with 36 respondents, accounting for 40.91% of the total 88 respondents. This is followed by HUMSS with 16 respondents (18.18%), STEM with 14 respondents (15.91%), ABM with 13 respondents (14.77%), and GAS with 9 respondents (10.23%). Overall, the data indicate that most respondents took the Tech-VOC strand during senior high school.

Table 2. Profile of the Graduates in Terms of Course Alignment

Strand	**f**	**RF**
YES	68	77.27
NO	20	22.73
Total	**88**	**100**

Table 2 presents the frequency and percentage distributions of respondents by course alignment. Most indicated YES (68 respondents, 77.27%), while 20 respondents (22.73%) reported NO, showing that most pursued college programs aligned with their SHS strand. These results align with previous studies (Tagulob et al., 2019; Mediana, 2023; Gonzales et al., 2024), indicating that SHS strands generally prepare graduates for aligned academic or career paths, though some choose different fields due to personal or external factors.

Table 3. Satisfaction with CVLIS' external factors

SATISFACTION	Mean	SD	Verbal Interpretation
1. Teachers' Instructions' Quality	3.68	0.47	STRONGLY AGREE
2. Learning Environment	3.59	0.52	STRONGLY AGREE
3. Safety, Security, and Disaster Preparedness	3.50	0.50	AGREE
4. Canteen/Food Services	3.09	0.62	AGREE
5. Sanitation (CR, Classroom, etc.)	3.07	0.75	AGREE
6. Information Dissemination	3.38	0.49	AGREE
7. Extra-Curricular Activities	3.44	0.62	AGREE
Overall Mean	**3.39**		**AGREE**

Legend: 3.51 – 4.0 STRONGLY AGREE; 2.51 – 3.50 AGREE; 1.51 – 2.50 DISAGREE; 1.0 – 1.51 STRONGLY DISAGREE

Table 3 shows respondents' satisfaction with different aspects of Limians' education. Teachers' Instructional Quality had the highest mean (M = 3.68, SD = 0.47) and Canteen/Food Services had the lowest (M = 3.09, SD = 0.62), with an overall mean of 3.06, indicating agreement that these aspects contributed to college and career success. School facilities and learning environments support effective teaching and learning (Hasbullah, Yusoff et al., 2011, as cited in Tondo et al., 2021), while insufficient facilities may affect performance (Limon, 2016, as cited in Tondo et al., 2021).

Table 4. Contribution of the senior high school program to graduates' development in terms of communication skills

COMMUNICATION SKILL	Mean	SD	Verbal Interpretation
1. I enhanced my ability to express ideas clearly in oral communication for academic and practical purposes. (e.g., class presentations, discussions)	3.66	0.50	STRONGLY AGREE
2. I enhanced my ability to express ideas clearly in written communication for academic and practical purposes. (e.g., essay writing, reports)	3.61	0.51	STRONGLY AGREE
3. The program helped me develop my ability to use appropriate language for different audiences.	3.61	0.51	STRONGLY AGREE
4. I strengthened my ability to share and exchange ideas during group activities.	3.64	0.51	STRONGLY AGREE
5. I learned how to give and receive constructive feedback respectfully.	3.67	0.50	STRONGLY AGREE
6. The SHS program trained me to listen actively and respond appropriately.	3.66	0.52	STRONGLY AGREE
7. I developed digital communication skills by using online platforms for academic tasks and collaboration.	3.61	0.53	STRONGLY AGREE
Overall Mean	**3.64**		**STRONGLY AGREE**

Legend: 3.51 – 4.0 STRONGLY AGREE; 2.51 – 3.50 AGREE; 1.51 – 2.50 DISAGREE; 1.0 – 1.51 STRONGLY DISAGREE

Table 4 presents respondents' assessment of their communication skills developed through Limians' education. All indicators received high mean scores, with the highest for "I learned how to give and receive constructive feedback respectfully" (M = 3.67, SD = 0.50) and an overall mean of 3.64, indicating strong agreement that their SHS education enhanced communication skills. These results align with Lenard et al. (2018) and Ferris (2014), showing that practicing communication skills in SHS prepares students for academic discussions, collaborative learning, workplace communication, and professional interactions.

Table 5. Contribution of the senior high school program to graduates' development in terms of problem-solving skills

PROBLEM-SOLVING SKILL	Mean	SD	Verbal Interpretation
1. I gained confidence in solving academic challenges independently through the SHS program.	3.59	0.54	STRONGLY AGREE
2. The program helped me apply creative thinking to overcome obstacles in both academic and non-academic settings.	3.52	0.55	STRONGLY AGREE
3. I learned to approach problems systematically by breaking them into manageable parts.	3.58	0.54	STRONGLY AGREE
4. The SHS program encouraged me to seek multiple perspectives when solving complex problems.	3.53	0.52	STRONGLY AGREE
5. The SHS program helped me think flexibly when solving problems.	3.61	0.51	STRONGLY AGREE
6. The SHS program helped me improve my ability to thoroughly analyze problems.	3.61	0.51	STRONGLY AGREE
7. The SHS program strengthened my confidence in making sound decisions when faced with problems.	3.61	0.51	STRONGLY AGREE
Over-all Mean	**3.58**		**STRONGLY AGREE**

Legend: 3.51 – 4.0 STRONGLY AGREE; 2.51 – 3.50 AGREE; 1.51 – 2.50 DISAGREE; 1.0 – 1.51 STRONGLY DISAGREE

Table 5 presents respondents' evaluation of problem-solving skills developed through Limians' education. The highest means (M = 3.61, SD = 0.51) were observed for thinking flexibly, analyzing problems thoroughly, and strengthening confidence in making decisions, with an overall mean of 3.58, indicating Strongly Agree that SHS education enhanced problem-solving skills. These findings align with Incebacak et al. (2016) and Ozturk et al. (2016), suggesting that CVLIS graduates can approach problems systematically and creatively, enhancing resilience and independence, while problem-based learning may further support preparedness for real-life challenges.

Table 6. Contribution of the senior high school program to graduates' development in terms of information literacy

INFORMATION LITERACY	Mean	SD	Verbal Interpretation
1.The SHS program helped me identify reliable sources of information.	3.63	0.49	STRONGLY AGREE
2. I enhanced my ability to use technology and online resources responsibly.	3.55	0.59	STRONGLY AGREE
3. I gained proficiency in properly citing sources and avoiding plagiarism through the SHS program.	3.55	0.52	STRONGLY AGREE
4. The program helped me apply information effectively to support my academic arguments or projects.	3.52	0.52	STRONGLY AGREE
5. I am aware of the ethical considerations related to using and sharing information.	3.59	0.52	STRONGLY AGREE
6. The program improved my skills in evaluating different solutions before choosing the best one.	3.55	0.52	STRONGLY AGREE
7. The SHS program encouraged me to learn from mistakes and apply lessons to future problems.	3.57	0.52	STRONGLY AGREE
Over-all Mean	**3.56**		**STRONGLY AGREE**

Legend: 3.51 – 4.0 STRONGLY AGREE; 2.51 – 3.50 AGREE; 1.51 – 2.50 DISAGREE; 1.0 – 1.51 STRONGLY DISAGREE

Table 6 presents respondents' assessment of information literacy developed through Limians' education. Identifying reliable sources received the highest mean (M = 3.63, SD = 0.49), with an overall mean of 3.56, indicating Strongly Agree that SHS education enhanced information literacy. These results align with Akor (2024) and Basque (2020), showing that CVLIS graduates are equipped to responsibly access, evaluate, and apply information, improving academic achievement, self-efficacy, and workforce readiness.

Table 7. Contribution of the senior high school program to graduates' development in terms of critical thinking skills

CRITICAL THINKING SKILL	Mean	SD	Verbal Interpretation
1.The program helped me develop the ability to evaluate ideas and arguments objectively.	3.50	0.53	AGREE
2. I gained the ability to apply logical reasoning to make informed decisions.	3.50	0.53	AGREE
3. The program encouraged me to reflect before making judgement.	3.52	0.50	STRONGLY AGREE
4. I became confident in vocabulary, which encouraged me to apply what I learned to improve my thought process.	3.52	0.52	STRONGLY AGREE
5. I gained critical thinking skills as an advantage in adapting to challenges in college and the workplace.	3.59	0.52	STRONGLY AGREE
6. I developed the habit of asking questions and clarifying ideas rather than accepting them at face value.	3.58	0.52	STRONGLY AGREE
7. I enhanced my problem-solving and decision-making skills.	3.53	0.55	STRONGLY AGREE
Overall Mean	**3.54**		**STRONGLY AGREE**

Legend: 3.51 – 4.0 STRONGLY AGREE; 2.51 – 3.50 AGREE; 1.51 – 2.50 DISAGREE; 1.0 – 1.51 STRONGLY DISAGREE

The findings of Table 7 show that Limians' education positively influenced the critical thinking skills of senior high school graduates from Camp Vicente Lim Integrated School, with an overall mean of 3.54 (Strongly Agree). Respondents agreed that the program helped them evaluate ideas objectively, apply logical reasoning, reflect before making judgments, and adapt critical thinking skills to college and workplace challenges, with the highest mean for applying skills to real-life challenges (M = 3.59, SD = 0.52). These results align with Evan Carla (2020), Nada (2020), and Tio (2016), indicating that the SHS program effectively develops critical thinking abilities essential for academic and professional success.

Table 8. Contribution of the senior high school program to graduates' development in terms of personal values

PERSONAL VALUES	Mean	SD	Verbal Interpretation
1.The program instilled in me a strong sense of integrity, particularly in academic honesty.	3.58	0.54	AGREE
2. I developed a greater sense of responsibility in managing tasks and meeting deadlines.	3.57	0.54	AGREE
3. The SHS program taught me the importance of ethical decision-making in both personal and academic situations.	3.61	0.51	STRONGLY AGREE
4. I learned to respect diversity and inclusivity through interactions with classmates from different backgrounds.	3.66	0.52	STRONGLY AGREE
5. The program helped me to be committed by following the school rules, embodying the school's core values, and showing interest in my studies.	3.59	0.54	STRONGLY AGREE
6. I developed better accountability in aspects of developing and achieving my goals by setting a clear vision, being resilient, and motivated.	3.56	0.54	STRONGLY AGREE
7. The SHS experience helped me develop resilience and self-control when faced with personal or academic setbacks.	3.64	0.53	STRONGLY AGREE
Over-all Mean	**3.60**		**STRONGLY AGREE**

Legend: 3.51 – 4.0 STRONGLY AGREE; 2.51 – 3.50 AGREE; 1.51 – 2.50 DISAGREE; 1.0 – 1.51 STRONGLY DISAGREE

The results of Table 8 indicate that Limians' education positively influenced the personal values of senior high school graduates from Camp Vicente Lim Integrated School, with an overall mean of 3.60 (Strongly Agree). Respondents agreed that the program enhanced integrity, responsibility, resilience, ethical decision-making, and respect for diversity, with the highest mean for promoting respect for diversity (M = 3.66, SD = 0.52). These findings align with Kohlberg's Theory of Moral Development, Bandura's Social Learning Theory, and Values Education Theory (McLeod, 2024; Suruso et al., 2024), suggesting that the SHS program effectively fosters personal values essential for ethical behavior, academic honesty, and professional conduct.

Table 9. Effectiveness of CVLIS' SHS Program

EFFECTIVENESS OF CVLIS' SHS PROGRAM	f	RF
4 - Very Effective	38	43.18
3 – Effective	48	54.55
2 - Ineffective	2	2.27
1 - Very Ineffective	0	0
Total	**88**	**100**

The data in Table 9 shows that the SHS program of Camp Vicente Lim Integrated School is generally perceived as effective. Out of 88 respondents, 48 (54.55%) rated it Effective, 38 (43.18%) Very Effective, and only 2 (2.27%) Ineffective, indicating that the majority view the program positively. These results align with Challenge and Threat Theory (Meijen et al., 2020) and Cognitive Load Theory (Sweller, 2020; Educational Research Review, 2020), suggesting that the SHS program effectively prepares students for post-secondary education and employment through well-structured teaching and academic support.

Table 10. Adequacy of CVLIS' SHS Program

ADEQUACY OF CVLIS' SHS PROGRAM	f	RF
4 - Very Adequate	37	42.05
3 – Adequate	48	54.55
2 – Inadequate	3	3.40
1 - Very Inadequate	0	0
Total	**88**	**100**

The data in Table 10 indicates that the SHS program of Camp Vicente Lim Integrated School is generally perceived as adequate. Among 88 respondents, 48 (54.55%) rated it as Adequate, 37 (42.05%) as Very Adequate, and only 3 (3.40%) as Inadequate, indicating that most respondents believe the program meets their academic and developmental needs. These findings align with Galabo and Seisa (2023) and Barnett et al. (2012), suggesting that CVLIS provides sufficient preparation for college and career while highlighting the need for ongoing assessment and enhancement of student support.

Table 11. Relevance of CVLIS' SHS Program

RELEVANCE OF CVLIS' SHS PROGRAM	f	RF
4 - Very Relevant	36	40.91
3 – Relevant	50	56.82
2 – Irrelevant	1	1.14
1 - Very Irrelevant	1	1.13
Total	**88**	**100**

The data in Table 11 shows that the SHS program of Camp Vicente Lim Integrated School is largely perceived as relevant. Of 88 respondents, 50 (56.82%) rated it as Relevant, 36 (40.91%) as Very Relevant, and 2 (1.14% + 1.13%) as Irrelevant/Very Irrelevant, indicating that most respondents view the program as aligned with their academic and career preparation. These findings align with Abrigo and Orbeta Jr. (2023) and Carada et al. (2022), suggesting that CVLIS effectively equips students with employable skills and that continuous curriculum review may further enhance relevance and graduate employability.

IV. Discussion

The study revealed that the majority of respondents were TECH-VOC graduates, with HUMSS, STEM, ABM, and GAS strands also represented, reflecting the diverse academic backgrounds of Senior High School (SHS) completers. College program choices were found to align closely with their respective strands, demonstrating the effectiveness of the SHS curriculum in preparing students for higher education pathways. Furthermore, respondents expressed high satisfaction with the quality of education at CVLIS, particularly with teachers' instructional competence. The SHS program was also credited for significantly enhancing essential skills such as communication, problem-solving, information literacy, critical thinking, and personal values. Overall, these findings affirm that the SHS program at CVLIS is effective, adequate, and relevant in equipping graduates for both college and career success.

Recommendations

Based on the findings of the study, several recommendations are proposed to further strengthen the effectiveness of the SHS program at CVLIS. It is recommended that the school invest in upgrading its learning facilities and instructional resources, including classrooms, laboratories, libraries, and digital tools, while also ensuring proper ventilation, hygiene, and sanitation across campus. Enhancing the school canteen and food services by providing safe and nutritious meals will also support students' health and academic performance. At the same time,

continuous faculty development in innovative teaching methods and technologies should be prioritized to sustain high instructional quality.

In addition, personalized career counseling, workshops, and internship opportunities should be expanded to help students make informed academic and career decisions. Establishing a formal alumni feedback system and conducting future tracer studies will provide valuable insights into graduates' career success and the long-term impact of the SHS program. These measures will ensure that CVLIS remains responsive, relevant, and effective in preparing students for both higher education and workforce demand.

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SCHOLARLY ATTAINMENT OF UNDERAGE STUDENTS ENGAGED IN PART-TIME WORK AT CAMP VICENTE LIM INTEGRATED SCHOOL

Authors: Angelo M. Bataller, Love Joy M. Bobadilla, Given Kurt Nicolai D. Ebuña, Chelle Ann L. Loquinto, Kimberly T. Lumibao, Rhiane M. Saavedra
School Year 2025-2026
Research Adviser: Virginia V. Papas

ABSTRACT

In the Philippines, many underage students engage in part-time work to meet personal needs and gain financial independence while continuing their education. This study examined the scholarly attainment of underage students engaged in part-time work at Camp Vicente Lim Integrated School. The study employed a descriptive correlational design to explore the relationship between part-time work involvement and students' scholarly attainment. Data were gathered from one hundred (100) Grade 7-12 students who are engaged in part-time work using a purposive sampling technique during the academic year. A semi-structured questionnaire was used as the primary data-gathering instrument. The study aimed to determine the extent to which factors such as task performance, class participation, academic standing, and Quarter 1 grades influence underage students' engagement in part-time work and their scholarly attainment. Furthermore, the study determined whether a significant relationship exists between part-time job involvement and scholarly attainment and identified possible support strategies that schools and families may implement to help underage students balance work and academic responsibilities.

KEYWORDS: *part-time work, scholarly attainment, underage students, descriptive correlational design, work and academic responsibilities*

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I. INTRODUCTION

In the Philippines, Republic Act No. 9251, which amends the "Special Protection of Children Against Child Abuse, Exploitation, and Discrimination Act," safeguards underage students engaged in work by setting clear rules and limitations to protect their health, safety, and education. The law generally prohibits the employment of children under 15 years old, except in limited cases, such as work under the sole responsibility of their parents or participation in public entertainment with the Department of Labor and Employment (DOLE) approval. It also restricts the number of working hours, no more than 4 hours a day and 20 hours a week for those under 15, and 8 hours a day and 40 hours a week for those aged 15 to 18, while banning night work. Most importantly, the law requires employers to ensure that working children have access to formal or non-formal education so that their schooling is not compromised by their employment.

Part-time work refers to a type of employment in which a person works fewer hours than a full-time job, typically less than 30 to 35 hours per week. It often involves flexible or limited schedules, such as working after school, on weekends, or during holidays. For students, part-time work is usually taken to earn money, gain experience, or help support their families. The global issue of underage students engaging in part-time work lies in its negative impact on scholarly attainment, as it often leads to reduced study time, stress, and lower achievement. Studies by McJames et al. (2024) and Garcia-Vargas et al. (2016) showed that excessive work hours are linked to slower academic progress and higher failure rates. This trend contributes to global educational inequality and weakens the future skilled workforce.

In recent years, the increasing number of underage students engaging in part-time work has raised concerns about its impact on their scholarly attainment, both globally and locally. In the Philippines, this issue is particularly evident among high school students, many of whom

come from low-income families and are compelled to work to meet their daily needs. While part-time work can offer valuable life skills and financial assistance, it often disrupts students' academic routines and contributes to lower scholarly attainment. Valdez et al. (2019) found that students who work more than 20 hours per week tend to have lower academic performance, with an average grade of 83.76 compared to 86.99 among non-working peers. This decline is attributed to time constraints, fatigue, and limited focus on academic responsibilities. Similarly, De Guzman et al. (2017) observed that working students face high levels of stress, poor time management, and reduced study time, all of which negatively affect their academic engagement. These findings highlight the urgent need to examine and address the local implications of student employment, especially as it continues to affect educational outcomes and long-term opportunities for Filipino youth.

Statement of the Problem

This research investigated the impact of part-time employment on the scholarly attainment of underage students. It analyzed the potential correlation between student work commitments and scholarly performance, with a particular focus on how employment may enhance or hinder academic outcomes. By examining this relationship, the study seeks to identify key factors influencing the educational attainment of students balancing school responsibilities with part-time work.

Specifically, it sought to answer the following:

1. To what extent do the following factors influence underage students' decision to engage in part-time work in terms of:
    1.1 Task Performance, and
    1.2 Class Participation?
2. How does the presence of a part-time job influence scholarly attainment among underage students in terms of:
    2.1 Quarter 1 grades, and
    2.2 Academic standing?
3. Is there a significant relationship between part-time job involvement and scholarly attainment?
4. Based on the findings, what support strategies can schools or families implement to help underage students manage the demands of work and academics?

Scope and Limitation

This study examined the scholarly attainment of underage students engaged in part-time work at Camp Vicente Lim Integrated School, focusing on Grades 7–12 learners below 18 years of age who balance academic responsibilities with employment. It aimed to determine the effects of part-time work on their scholarly attainment, as reflected in their overall academic averages,

and to explore their experiences in managing both school and work demands. The study was conducted during the 2025–2026 school year, with data collected through survey questionnaires administered to the identified respondents.

II. METHODOLOGY

This section presents the research design, population and sampling, research instrument, and statistical treatment of data of the study

.

Research Design

This research employed a descriptive-correlational design to establish the degree of association or correlation between variables. It reflects the strengthening relationship between underage students' part-time work engagement and their scholarly attainment. This design is appropriate because it describes the status of the two variables and then assesses if an existing statistical relationship exists between them. The researchers primarily focus on characterizing the relationship rather than demonstrating a causal relationship.

Population and Sampling

The population of this study consisted of high school students aged 17 and below at Camp Vicente Lim Integrated School who are engaged in part-time work. The researchers used a non-probability sampling method, specifically purposive sampling, to select participants who met the needed criteria for the study. The target respondents include both male and female respondents from the school. This method ensured that the participants were suitable to answer the research questions on part-time employment and students' scholarly attainment.

Research Instrument

This study utilized a semi-structured questionnaire to gather data on part-time work and scholarly attainment, developed in alignment with the study's problem statement. Part I adopted an existing questionnaire to collect respondents' background information. Part II drew from secondary sources, specifically respondents' Quarter I grades and academic standing, obtained in accordance with DepEd Order No. 36, s. 2016–2017 to ensure data accuracy and consistency. The instrument comprised two main sections: (1) factors affecting scholarly attainment: task performance and class participation, and (2) grades and academic standing, measuring the influence of part-time employment. Responses were measured using a 5-point Likert scale. The questionnaire was administered manually through printed copies to eligible participants, allowing direct engagement and immediate clarification.

Statistical Treatment of Data

The relationship between part-time work and scholarly attainment was analyzed using the weighted mean and the t-test. The weighted mean was employed to assess students' scholarly attainment while engaged in part-time work, as it accounts for the varying importance of responses and provides a more accurate measure of central tendency than the simple mean (Taylor, 2024). The independent samples t-test was used to determine whether a statistically significant difference existed in scholarly attainment between working and non-working students, thereby testing the study's hypothesis on group differences and identifying whether observed differences reflected true population effects.

III. RESULT

This part presents the statistical data and its corresponding analysis and interpretation of the study.

Table 1. Task Performance

Task Performance	Weighted Mean	Interpretation
1	3.00	Neutral
2	3.59	Agree
3	3.53	Agree
4	3.95	Agree
5	4.09	Agree
6	3.41	Neutral
7	3.70	Agree
8	3.73	Agree
9	4.07	Agree
10	3.93	Agree
Composite Mean	3.70	Agree

The results show that respondents generally agreed that certain factors influenced their decision to seek part-time work, with a composite mean of 3.70. While some factors strongly influenced them, others received a neutral response. According to Neyt et al. (2017), working while studying can negatively affect academic performance, especially when students work many hours, but flexible schedules can help reduce these effects.

Table 2. Class Participation

Class Participation	Weighted Mean	Interpretation
1	3.87	Agree
2	3.66	Agree
3	3.95	Agree
4	3.82	Agree
5	3.81	Agree
6	3.57	Agree
7	3.65	Agree
8	3.97	Agree
9	3.77	Agree
10	3.84	Agree
Composite Mean	3.79	Agree

The results present that respondents agreed that certain factors related to class participation influence their decision to engage in part-time work, with a composite mean of 3.79. Both the highest- and lowest-weighted means are interpreted as "Agree," indicating consistent responses. According to Greene et al. (2015; 2017), spending more time working may reduce the time students have for their academic studies.

Table 3. Quarter 1 Grades

Grade	Frequency	Percent
75 below	0	0
75-79	7	7
80-84	21	21
85-89	48	48
90-100	24	24
Total	100	100

Most respondents, 48%, fall into the "Very Satisfactory" grade category, indicating that many working students are still able to maintain good academic performance. None of the respondents have grades of 75 and below. Overall, the results suggested that students who work part-time can still perform well in school. However, Kroupova (2021) explained that working while studying may have a slightly negative effect on academic performance, though the impact is usually small and depends on the student's situation.

Table 4. Academic Standing

Standing	Frequency	Percent
None	76	76
With Honors	23	23
With High Honors	1	1
Total	100	100

Based on Table 4, 76% of respondents have no academic standing, while only 1% have high academic standing, indicating that few working students achieve top academic performance. This suggests that balancing work and school can make it challenging to achieve high grades. Staff et al. (2022) supported this, noting that students working over 20 hours per week often perform worse academically. Even students motivated to work long hours can face similar difficulties, highlighting that both time management and commitment to school affect academic outcomes.

Table 5. Relationship Between Part-Time Work Involvement and Scholarly Attainment

Class Participation VS	Rho-value	p-value	Interpretation
Quarter 1 Grade	**.097**	**.339**	**Not Significant**
Academic Standing	**.063**	**.536**	**Not Significant**

The results indicate **no significant relationship** between class participation and both quarter 1 grades ($\rho = 0.097$, $p = 0.339$) and academic standing ($\rho = 0.063$, $p = 0.536$). Hurdhaugeh (2015) noted that working while studying is a common factor in student dropouts, with full-time working students less likely to complete their programs than those working part-time or not at all. According to Kroupova (2021), ignoring factors such as motivation and socioeconomic status can overstate the negative effects of work, suggesting that the impact of working on learning depends on individual circumstances and study habits.

IV. DISCUSSION

Based on the findings of the study, it can be concluded that the respondents were underage students engaged in part-time work, representing the total sample population of the research. The results showed that the respondents generally agreed that factors related to task performance and class participation influenced their decision to engage in part-time employment, as indicated by composite mean scores interpreted as “Agree.” Among these factors, task performance obtained the highest weighted mean, suggesting that students consider work-related responsibilities as a significant factor in deciding to work while studying.

Despite their employment, most respondents demonstrated very satisfactory academic performance, with the majority obtaining average grades and having no academic standing issues. However, only a small number of working students achieved high academic standing, indicating that balancing part-time work with academic excellence remains challenging for underage students.

Furthermore, correlation analysis revealed no significant relationship between part-time work involvement, specifically task performance and class participation, and students' grades and academic standing. Overall, the findings suggest that although various factors influence underage students' engagement in part-time work, such involvement does not significantly affect their scholarly attainment.

Recommendations

Based on the findings of the study, several recommendations are proposed to better support underage students engaged in part-time work. Teachers are encouraged to promote effective time management strategies to help students balance academic responsibilities and employment demands. Strengthening school-based support systems is also recommended to assist working students in maintaining their scholarly attainment. Schools may develop policies and programs, such as symposiums, that acknowledge the circumstances of working students and ensure that their educational progress is not adversely affected.

Furthermore, providing guidance services and academic assistance can further help students cope with academic and work-related responsibilities, while flexible arrangements in academic requirements may be considered to accommodate their needs. To deepen understanding of the impact of part-time employment on underage learners, future studies may explore additional variables such as work hours, job type, and long-term academic outcomes.

Likewise, basic skills training and task orientation programs are recommended to enhance students' task performance and confidence in part-time work. Flexible participation options, including online discussions or alternative learning activities, may help working students remain actively engaged in class. Continuous academic support initiatives, such as mentoring, tutoring, and regular academic monitoring, should be established to sustain scholarly attainment. Lastly, enrichment and honors-support programs specifically designed for working students, such as flexible access to advanced courses, scholarship guidance, and sustained academic mentoring, are encouraged to promote academic excellence despite employment commitments.

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SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

REPLICATION OF DRYVE: ENCAPSULATED DRYING MACHINE FOR FASTER ORGANIC FERTILIZER DECOMPOSITION FOR RESIDENTIAL AREAS (2025)

Authors: Dan Daniel Agawin, Sharmae A. Antonio, Romnick G. Budejas, Izee T. Calvadores, Zoila Allaney C. Honrada, Sophia Salve R. Onte, Jasmine M. Panganiban, Yzahvel R. Parala, Kenny V. Salazar, Ma. Cyries S. Samiano, Niño Carl H. Sorino
School Year 2025-2026
Research Adviser: Virginia V. Papas

ABSTRACT

A drying machine offers an alternative to sun-drying, which can take months and is often hindered by unfavorable weather. However, existing drying machines are primarily designed for large-scale farms or industry. This study presented an improved small-scale drying machine suitable for residential areas. Through a series of experiments, the machine's performance and efficiency in drying organic waste were evaluated. The results show that the machine is durable and achieves an optimal drying time of up to 2 hours and 45 minutes at 110°C while consuming only 0.85 kilowatts per hour. Furthermore, thermal and airflow analyses showed uneven heat distribution by waste type, resulting in varying moisture content removal across the different layers of the drying rack. Specifically, a temperature of 110°C achieved moisture content removals of 16-64%, 53-88%, 56-94%, 45-86%, 91- 97%, and 88-96%, respectively. In general, this innovative small-scale drying machine enables residents to efficiently dry organic waste and produce their own fertilizers, enhancing fruit and vegetable yields, and promoting sustainable waste management practices.

KEYWORDS - *Dryve, environmental waste, drying machine, mechatronics, residential unit*

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I. Introduction

Household food waste (HFW) poses a major global sustainability issue, hindering progress towards development. Globally, around 931 million tons of food are wasted each year, with consumers playing a substantial role in it. Additionally, the common causes of HFW include overproduction, excessive purchasing, poor meal planning, and misunderstandings about expiration labels, all of which contribute to waste throughout the food supply chain. Tackling HFW is vital to combat hunger, mitigate climate change, ensure food security, and conserve resources, promoting sustainability and improving quality of life (Hinson et al. 2025).

Dehydration has been widely used in both the food industry and agriculture. According to O'Connor et al. (2021), dehydration is a process in which the water components of a particular food or food waste have been evaporated to form a product that has a low moisture content. This technique is often used for managing food waste by converting it to organic fertilizers. This promotes sustainable agricultural practices by recycling nutrients, reducing reliance on synthetic fertilizers, and conditioning soils (O'Connor et al., 2024).

A previous study by Abalus et al. (2025) developed the Dryve: Encapsulated Drying Machine for Faster Organic Fertilizer Decomposition to address the slow drying rates of organic waste. While the prototype proved effective, its design still had areas for improvement in terms of user safety, energy efficiency, mobility, and heat distribution. Gholami et al. (2021) and Obi et al. (2023) emphasize that product design directly impacts user efficiency, productivity, and safety, making targeted enhancements crucial for widespread adoption.

By addressing both technical and usability gaps in the original prototype, this study seeks to contribute to sustainable waste management and promote the circular use of food waste in residential settings. Danda (2023) found that the adoption of advanced agricultural machinery and technologies significantly enhanced farm production efficiency by improving mechanization quality, optimizing resource use, and accelerating productivity growth, thereby contributing to sustainable agricultural development. Ultimately, these improvements aim to reduce the disposal of organic waste, support soil health, and encourage eco-friendly farming practices.

Statement of the Problem

This study aimed to replicate and enhance the functionality of the Encapsulated Drying Machine for faster Organic Fertilizer Decomposition for Residential Areas (Dryve).

Specifically, the study sought to address the following questions:

1.) How does the drying machine perform in terms of:
- 1.1. safety of materials:
  - 1.1.1. without breaker,
  - 1.1.2. with breaker,
- 1.2. durability of materials,
- 1.3. efficiency and drying speed, and
- 1.4. moisture content?

2.) How efficient is the drying machine in terms of:
- 2.1. energy consumption using;
  - 2.1.1. insulator foam sheet,
  - 2.1.2. fiberglass insulator,
- 2.2. mobility;
  - 2.2.1. without wheels,
  - 2.2.2. with wheels, and
- 2.3. heat distribution?

3.) Based on the results of the study, what conclusions can be drawn?

Scope and Limitation

This study is a replication and improvement of a previous research project that developed an electricity-based drying machine to reduce the traditional one-month drying period of organic waste fertilizers. Conducted at Camp Vicente Lim Integrated School in Calamba, Laguna, the study aims to enhance the machine's durability, efficiency, energy consumption, heat distribution, safety, and mobility through a series of trials. The improved design is limited to small-scale or household use and focuses on the machine's construction, functionality, drying time, and moisture reduction. It excludes commercial applications, solar drying methods, and analysis of fertilizer nutrient composition or long-term soil effects, emphasizing the practicality and effectiveness of the improved design for residential users instead.

II. METHODOLOGY

By comprehensively describing these elements, this chapter provides a transparent understanding of the scientific process and development followed throughout the research.

Conceptual Framework of the Study

This conceptual framework presents the functional flow of the enhanced encapsulated drying machine "Dryve," detailing its design principles, operational systems, and the factors that influence its performance.

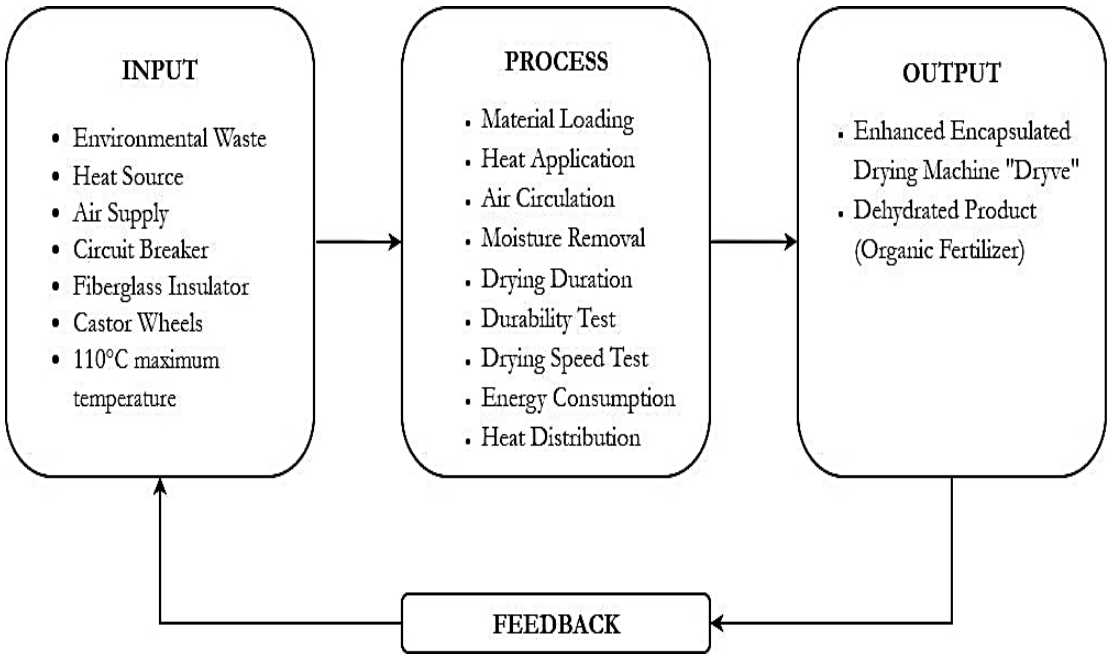

Figure 1. Input-Process-Output Method (IPO Method)

Figure 1 illustrates the Input–Process–Output (IPO) Model used in the study (Agus et al., 2020). The input includes the original materials, agricultural waste, a heat source, and air supply along with added components such as a circuit breaker for safety, a fiberglass insulator sheet for improved heat retention, and castor wheels for mobility. The process involves material loading, heat application, air circulation, moisture removal, and performance testing. The output is an enhanced encapsulated drying machine that produces dried organic material for high-quality organic fertilizer, with feedback used to refine the input and process stages.

Research Methodology Flowchart

Product Design

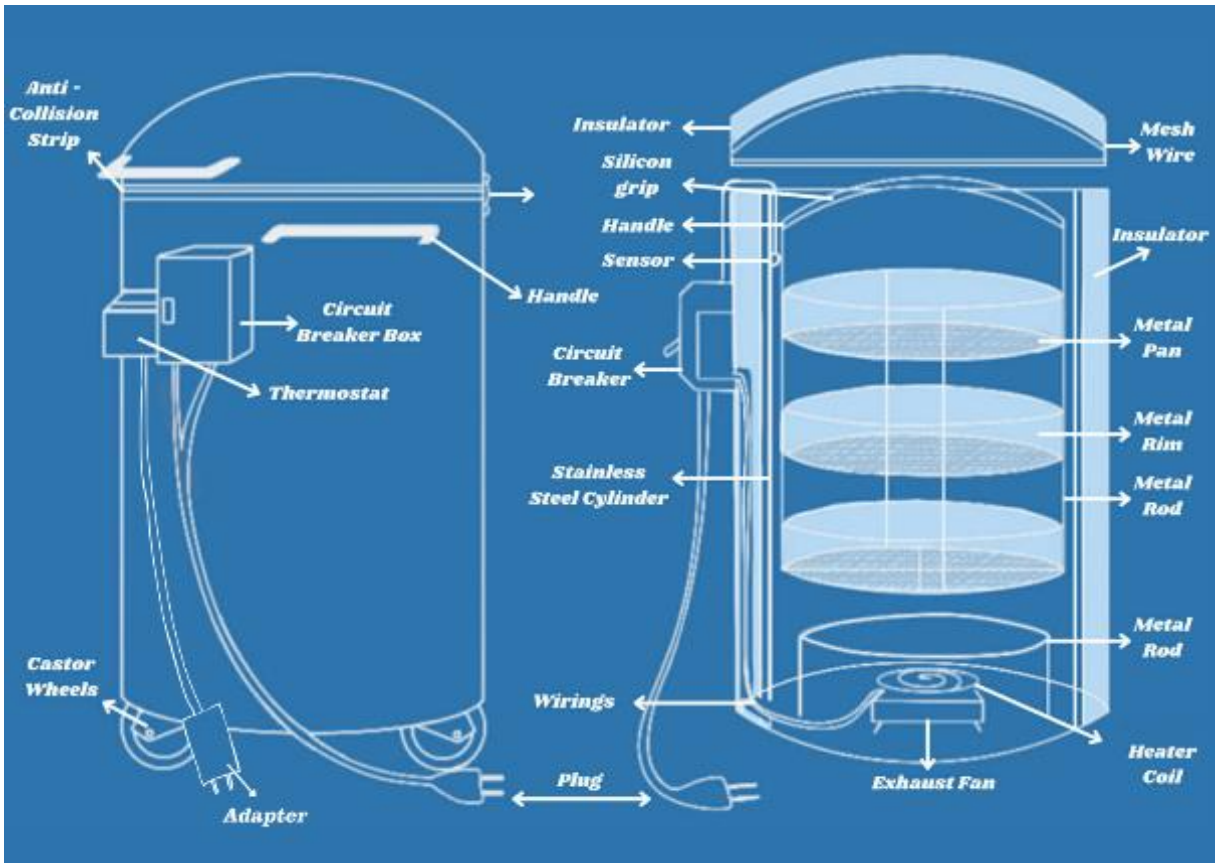

Figure 2 shows the blueprint of the encapsulated drying machine, featuring a cylindrical design measuring 16 inches in diameter and 25.4 inches in height. It includes key components such as a stainless-steel cylinder, internal trays, a sensor, a thermostat, a heating coil, an exhaust fan, and integrated wiring. The upgraded design incorporates fiberglass insulation for heat retention, a circuit breaker for safety, silicone-covered handles, and castor wheels for mobility. Together, these features enhance temperature control, heat distribution, moisture removal, energy efficiency, safety, and portability.

System Flowchart

Figure 3. Flow Chart of the System

Figure 3 illustrates the flowchart of the research methodology. The first part is the preparation of all required materials and components, such as the pressure tank, heater coil, stainless steel sheet, thermostat, and insulating materials like foam sheet and fiberglass, together with the tools needed, including a welding machine, grinder, soldering equipment, and electrical devices. The second step focuses on assembling the different setups under varying amounts of the needed data. Third, the tests that were done include safety materials, durability test, efficiency and drying speed test, moisture content, energy consumption test, grip comfort, portability, and

heat distribution. Last is the encapsulated drying machine, which is the desired outcome of the study.

Table 1. Materials and Equipment

Quantity	Unit	Materials/Equipment
1	piece	Angle Bar
1	set	Castor Wheels
1	sheet	Fiberglass Insulator
2	cans	High-temp Spray Paint
1	sheet	Insulator Sheet
1	sheet	Mesh
1	piece	Metal Rod
1	sheet	Metal Sheet
1	piece	Miniature Circuit Breaker
2	bottles	Oily Glue
1	piece	Power Adapter
1	set	Rivets
5	meters	Silicone Tube
5	meters	Solid Wire
2	cans	Spray Paint
5	meters	Stranded Wire
1	piece	Sub Meter
1	piece	Thermostat
1	piece	Wire Sleeves

Table 1 presents the costs of the new materials used in constructing the encapsulated drying machine. Key components include a power adapter for electrical supply, angle bars and castor wheels for structural support and mobility, and fiberglass insulation with insulator sheets and mesh to prevent heat transfer and material exposure. High-temperature spray paint, metal rods, and metal sheets enhanced durability and protection, while a miniature circuit breaker improved electrical safety. Supporting materials such as oily glue, rivets, silicone tubing, solid and stranded wires, wire sleeves, a thermostat, and a sub-meter ensured proper assembly, temperature control,

user comfort, and accurate power consumption monitoring. Overall, primary materials accounted for the majority of the cost, while supporting materials contributed to the machine's durability, efficiency, and safety.

Treatment and General Procedures

This project centers on the design and development of an efficient organic waste drying machine. The process aims to produce a stable, durable, and well-structured system capable of effectively drying various organic materials.

Drying Racks

1. Prepare circular aluminum pans, about 12 inches in diameter, to serve as the base of each drying layer.
2. Fix metal rods on the sides of the racks to give them support and keep them steady.
3. Arrange the racks vertically, leaving enough gaps between each layer to allow good airflow and effective drying.
4. Make sure all racks are firmly in place, with proper spacing and strength to hold the organic materials.

Machine's Body

1. Make the Body

– First, form the stainless-steel sheets into a tall cylinder (about 21 inches wide).

– After that, attach four caster wheels under the cylinder so that the machine can be moved easily.

– Next, install a hinged lid on top and attach a handle that is covered with a silicone grip for safe and comfortable use.

2. Install Trays and Support

–First, place a cylindrical metal rod support at the bottom of the dryer close to the heating coil to support the drying racks.

–Second, ensure that there is a space between each tray layer for hot air to pass through evenly.

3. Add Heating and Exhaust

– Fix an improved heating coil made of copper at the lower part of the cylinder.

– Then install the exhaust fan below it for proper airflow.

4. Apply Insulation

– Firstly, line the inner wall with fiberglass insulation.

– After that, secure it using mesh wire or a thin sheet.

5. Install Electrical Components

– First, mount a casing/box on the outside of the machine.

– Upon doing that, place the circuit breaker and thermostat inside the casing.
– Next, pass the thermostat sensor inside the chamber.
– Finally, connect all wiring: plug → breaker → thermostat → heating coil + fan.
6. Final Setup
– First, check that the lid closes tightly.
– Second, plug in the machine and test if the heater warms up and the fan circulates air.
– Lastly, make sure the thermostat controls the temperature and the breaker trips for safety.

Electrical Wiring

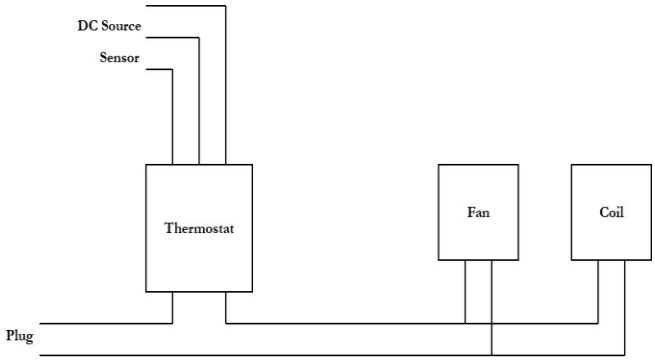

Figure 4. Electrical Diagram

The researchers used a block diagram to easily identify the connection of the parts of the device and to determine the parts that were used in the machine.

1. Five devices are used: circuit breaker, thermostat, exhaust fan, coil, and sensor.
2. The breaker is connected to the source.
3. To connect the coil and fan, there are two terminals in the breaker: the source and load.
4. The wires in the fan and coil are in a series connection going to the load of the thermostat.
5. The load is also supplied with 220v through the output of the breaker.
6. The thermostat has a power supply.
7. To open the thermostat, the power supply is connected to the DC source terminal.
8. Lastly, the sensor is series-connected to the thermostat.

Testing Process

The researchers' objective is to evaluate the effectiveness of the improved parameters of small-scale drying machines in accelerating the decomposition time and drying rate of waste fertilizer. Data collection for this study is conducted at Camp Vicente Lim Integrated School, Mayapa, Calamba City, Laguna. The structure and component designs are essential in the drying

process. With this, the researchers can assess the performance of the drying machine in terms of the following tests.

1. Durability test

An effective drying machine should be capable of completing the full drying process without sustaining damage. This principle is shown in design studies that emphasize durability through material selection and structural measures to withstand thermal stress during the drying process (Agberegha et al., 2023). To evaluate its durability, data were collected to identify any changes or signs of damage that occurred during repeated trials. Through this procedure, the researchers ensured that the components of the drying machine remained in proper condition for optimal functionality.

2. Drying speed test

Organic wastes were similarly prepared and spread evenly on the racks of the drying machine so that they were uniformly exposed to heat and airflow. The researchers monitored visible moisture-evaporation speed, texture changes, and weight variations before and after each trial.

3. Energy consumption test

The energy efficiency of the improved machine was tested by operating it under the upgraded conditions. The drying machine used fiberglass insulation with a density of 14.67 kg/m^3, which falls within acceptable standards (Stephenus et al., n.d.). Energy consumption was measured in kilowatt-hours (kWh) during each drying cycle under varying airflow and temperature conditions. Previous studies indicate that higher air humidity increases energy consumption, while higher drying temperatures improve evaporation rates and reduce energy use (Yin et al., 2022; Kocabay et al., 2024). This test aimed to identify the insulation setup that provided better heat retention and lower electricity consumption. Energy usage was measured using a sub-meter, with consumption recorded over one hour, as kilowatt-hours are the standard unit for assessing electrical energy use.

4. Mobility test

An effective drying machine must have a lightweight design, compact structure, and durable yet easy-to-carry components. Product portability refers to a machine's ability to be easily and safely moved and used in different situations without increasing user effort. Incorporating portability enhances usability, flexibility, and overall user experience (Hwang et al., 2015).

According to Jayzmine (2024), castor wheels are critical for material handling equipment because they provide reliable mobility, reduce manual labor, and improve safety. These wheels adapt to challenging environments while delivering unmatched durability and performance.

These evaluations aim to assess the machine's efficiency in terms of mobility, user convenience, and operational stability, ensuring that portability does not negatively affect the overall drying performance. The mobility of the machine is perpendicular to the measured weight; the lower the weight, the higher the mobility, and if the mobility is increased, so does its portability (Del Pero et al., 2020).

5. Heat distribution

An effective drying machine must be capable of delivering uniform heat to ensure consistent drying (Asrate et al., 2025). To monitor heat distribution during operation, the researchers adjusted temperature settings to identify areas of uneven heating and to optimize the drying process, ensuring efficient energy consumption and consistent drying of organic waste. These evaluations were conducted to enhance the performance of small-scale drying machines. By analyzing these factors, the researchers improved both the design and operational efficiency of the machine, resulting in faster, more cost-effective, and sustainable drying of waste fertilizer.

Evaluation Procedure

Evaluation of the "Dryve" drying machine addressed various points, such as durability, rate of drying, utilization of energy, efficiency in size, and heat distribution. In an attempt at collecting data, the researchers observed the machine's performance descriptively, recorded numerical data in tables, and established its limit of operation under diverse scenarios.

Statistical tests may apply in the comparison of the findings from each of the trials in establishing significant differences in the performance. The procedure was that of facilitating the researchers in establishing the extent to which the machine is performing under various conditions. Finally, the assumptions in the design and the procedures in the test were investigated in establishing validity in the observations as well as the areas in which the enhancements are required.

Table 2. Experiment Set-Up

	Set A	Set B	Set C	Set D	Set E	Set F
Temperature	Drying Machine at 110℃	Drying Machine at 110℃	Drying Machine at 110℃	Drying Machine at 110℃	Drying Machine at 110℃	Drying Machine at 110℃
Watts	850 Watts	850 Watts	850 Watts	850 Watts	850 Watts	850 Watts
Weight	Organic Waste is 500 grams	Organic Waste is 200 grams	Organic Waste is 330 grams	Organic Waste is 330 grams	Organic Waste is 200 grams	Organic Waste is 250 grams
Time	Drying Machine running for 2 hours	Drying Machine running for 2 hours	Drying Machine running for 2.5 hours	Drying Machine running for 2.5 hours	Drying Machine running for 2.75 hours	Drying Machine running for 2.75 hours
Capacity	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space

Table 2 presents the experimental set-ups used to evaluate the drying machine's performance, consisting of six runs labeled Set A to Set F. All set-ups were conducted at a constant drying temperature of 110 °C and a drying rack capacity of 1.5 kg to ensure controlled conditions. The mass of organic waste and operating time were systematically varied across the sets to examine their effects on drying performance. Overall, this design allowed a controlled comparison of the machine's efficiency under different load weights and drying durations.

Statistical Treatment

To calculate the moisture content loss of a material, the researchers utilized the moisture content formula on wet basis (Biswas et al., 2021).

$$MC_{wb} = \frac{W_i - W_f}{W_i} \times 100$$

Moisture Content Wet Basis

The researchers incorporated castor wheels to identify if the machine can be easily transferred from one place to another without compromising its stability and performance. To further compare the mobility, the following formulas will be used (Udegbunam, 2021).

F = mg	Fr = cW
Gravitational Force acting on Mass	Resistance due to Rolling Friction

Table 3. Costing

This part of the study showed the materials and ingredients used to make the product.

MATERIAL	COMPONENT ANALYSIS	PURPOSE
Angle Bar	PRICE: 400 php QUANTITY: 1 pc.	The angle bar will be welded together to serve as a frame for the wheels.
Castor Wheels	PRICE: 185 php QUANTITY: 1 set (4 pcs)	The castor wheels will be attached onto the frame under the machine for better mobility.
Fiberglass Insulator	PRICE: 5,290 php QUANTITY: 1 sheet.	The fiberglass insulator will act as a primary insulator inside the machine due to its high heat resistance rate.
High-temp Spray Paint	PRICE: 180 php QUANTITY: 2 pc.	The high-temp spray paint will be used as the first coat of the machine, preventing damage caused by heating while operating.
Insulator Sheet	PRICE: 180 php QUANTITY: 1 sheet	The insulator sheet will serve as a second layer insulator to ensure proper heat retention inside the chamber.
Mesh	PRICE: 280 php QUANTITY: 1 sheet	The mesh will be used to cover the exposed portions of the insulation.
Metal Rod	PRICE: 280 php QUANTITY: 1 pc	The metal rod will be welded together to form a frame for the drying racks, exhaust fan, heater coil, and handles.
Metal Sheet	PRICE: 350 php QUANTITY: 1 sheet	The metal sheet will act as the divider of the actual chamber from the insulation.
Miniature Circuit Breaker	PRICE: 250 php QUANTITY: 1 pc	The miniature circuit breaker will be installed, ensuring safety while operation by automatically switching off the system when a short circuit occurs.
Oily Glue	PRICE: 78 php QUANTITY: 1 pcs	The oily glue will act as an adhesive for the silicone tubes.
Power Adapter	PRICE: 40 php QUANTITY: 1 pc	The power adapter will be used to power the thermostat of the machine.
Rivets	PRICE: 56 php QUANTITY: 1 set	The rivets will be used so that the caster wheels could be attached on the frame under the chamber.
Silicone Tube	PRICE: 480 php QUANTITY: 5 meters	The silicone tubes will be used to protect the handles from heat and possible grounding; as well as an anti-collision strip for the lid of the machine.
Solid Wire	PRICE: 125 php QUANTITY: 5 meters	The solid wire will be used to connect the components of the machine inside the chamber because of its ability to resist high temperatures.
Spray Paint	PRICE: 280 php QUANTITY: 2 cans	The spray paint will be used a second coat to improve the machine's external appearance.
Stranded Wire	PRICE: 125 php QUANTITY: 5 meters	The stranded wires will serve as the primary wires of the machine to connect its parts.
Sub Meter	PRICE: 1,595 php QUANTITY: 1 pc	The sub meter will be used to accurately measure the kilowatts the machine is consuming in an hour.
Thermostat	PRICE: 521 php QUANTITY: 1 pc	The thermostat will serve as a medium to manipulate and monitor the temperature inside the machine.
Wire Sleeves	PRICE: 89 php QUANTITY: 1 pc	The wire sleeves will be used to protect the wires while also keeping the wiring system outside the machine neat.

The overall construction of the encapsulated drying machine's new materials consists of the power adapter, angle bar, castor wheels, fiberglass insulator, high-temp spray paint, insulator sheet, mesh, metal rod, metal sheet, miniature circuit breaker, oily glue, rivets, silicone tube, solid wire, spray paint, stranded wire, sub-meter, thermostat, and wire sleeve, with a total cost of Php 10,964.00. The primary materials contributed significantly to the overall cost, while the supporting materials ensured the durability and safety of the drying machine.

IV. Results

This chapter focuses on presenting, examining, and interpreting the data obtained from the experimental setups conducted. The findings are analyzed in line with the research objectives and existing literature to provide insights into the performance of the developed drying technology and identify potential areas for improvement.

Table 4. Durability Testing Results (table results from each trial and category)

Set Ups	Operating Time	Corrosion
Set A	2 hours	No Effect
Set B	2 hours	No Effect
Set C	2.5 hours	No Effect
Set D	2.5 hours	No Effect
Set E	2.75 hours	No Effect
Set F	2.75 hours	No Effect

Observations:

Table 4 shows that during the trial, the machine successfully operated for up to 5.5 hours without any signs of damage, malfunction, or performance degradation. The devices are still functional and intact. The results showed no signs of rusting, deterioration, or structural weakness, indicating that the materials used were resistant to corrosion. Periodic cleaning may still be necessary to prevent salt buildup.

Furthermore, the organic waste inside the machine remained unaffected, confirming that the internal drying process was not compromised. Overall, the test confirmed that the machine is durable and capable of withstanding moisture and salt exposure without affecting its normal operation.

Table 5. Efficiency and Drying Speed Test

	Set A	Set B	Set C	Set D	Set E	Set F
Duration	2 hours	2 hours	2.5 hours	2.5 hours	2.75 hours	2.75 hours
Temperature	110°C	110°C	110°C	110°C	110°C	110°C
Weight	500 grams	200 grams	330 grams	330 grams	200 grams	250 grams

Observations:

Table 5 presents the drying duration and efficiency tests conducted at a constant temperature of 110 °C, with moisture condition monitored every 30 minutes and weight measured hourly. Results showed that shorter drying times and heavier loads (Sets A and B) led to slower and uneven moisture removal, primarily in the lower layers of the drying rack. Improved drying performance was observed as drying time increased and sample weight became more moderate, with Sets E and F demonstrating the most uniform drying and lowest remaining moisture across all rack layers. These findings are consistent with Tun et al. (2019), who emphasized that optimal drying efficiency is achieved through proper balance of drying time and load weight. Overall, Sets E and F achieved the highest drying efficiency, indicating that longer drying durations combined with moderate sample weights significantly enhance moisture removal at a constant temperature.

Table 6. Energy Consumption Test

Set-ups	Watts	Hours	Kilowatts per hour (kph)
Set A	850 watts	2 hours	1.7 kWh
Set B	850 watts	2 hours	1.75 kWh
Set C	850 watts	2.5 hours	2.125 kWh
Set D	850 watts	2.5 hours	2.125 kWh
Set E	850 watts	2.75 hours	2.3375 kWh
Set F	850 watts	2.75 hours	2.3375 kWh

Observations:

Table 6 presents the electrical power consumption of the drying machine across all experimental setups, with the machine operating at a constant power rating of 850 W. Because energy use depended on operating time, Sets A and B (2 hours) consumed 1.7 kWh, Sets C and D (2.5 hours) consumed 2.125 kWh, and Sets E and F (2.75 hours) recorded the highest consumption at 2.3375 kWh. Energy data were obtained using a sub-meter, which measured 0.85 kWh during one hour of continuous operation and was used to confirm the machine's power rating and calculate total energy consumption for each setup.

$$W = kWh \times 1000$$

Kilowatts to Watts

After obtaining the watts of the drying machine, it will be multiplied and divided again to be able to determine how much electrical power it is consuming, or its kilowatts per hour. The consumed kilowatts per set was obtained by using this formula.

$$kWh = \frac{W \times t}{1000}$$

Kilowatts consumed

Table 7. Heat Distribution and Moisture Percentage

	Layer	Actual Weight	Dried Weight	Percent
Set A	1	500 g	420 g	16%
	2	500 g	355 g	29%
	3	500 g	180 g	64%
Set B	1	200 g	95 g	53%
	2	200 g	45 g	78%
	3	200 g	25 g	88%
Set C	1	330 g	144 g	56%
	2	330 g	72 g	78%
	3	330 g	20 g	94%
Set D	1	330 g	185 g	44%
	2	330 g	75 g	77%
	3	330 g	45 g	86%
Set E	1	200 g	18 g	91%
	2	200 g	12 g	94%
	3	200 g	6 g	97%
	1	250 g	30 g	88%
	2	250 g	22 g	91%
	3	250 g	10 g	96%

Observations:

Table 7 presents the heat distribution and moisture reduction across the different layers of the drying machine. Results show that drying efficiency improved progressively from Set A to Set E, with Set A exhibiting the lowest moisture reduction due to uneven heat distribution, particularly in the upper layers. Sets B, C, and D demonstrated moderate to high moisture removal, reflecting improved heat penetration, although some layer inconsistency remained. Set E recorded the highest and most uniform moisture reduction across all layers, indicating optimal heat distribution and drying conditions, followed closely by Set F. Overall, Set E proved to be the most efficient setup, while Set A showed the least efficiency and may require design or operational improvements.

Table 8. Safety Test

	Set A	**Set B**	**Set C**	**Set D**	**Set E**	**Set F**
Set Temperature (°C)	110°C	110°C	110°C	110°C	110°C	110°C
Thermostat Reading (°C)	110°C	110°C	110°C	110°C	110°C	110°C
Circuit Breaker Status	No Activation Observed	No Activation Observed	No Activation Observed	Activated (Single Occurrence)	No Activation Observed	No Activation Observed
Safety Remarks	Stable Operation	Stable Operation	Stable Operation	Automatic Safety Shutdown	Stable Operation	Stable Operation

Observations:

Table 8 shows that the circuit breaker was activated twice during initial testing due to high thermal load from the heating coil; however, these issues were resolved through system calibration before formal trials. During the official trials at a constant temperature of 110 °C, the thermostat maintained stable temperature control, and the circuit breaker activated only once, triggering an automatic safety shutdown. This response is consistent with the protective function of circuit breakers, which interrupt power during abnormal electrical conditions

(Alharbi et al., 2020). Overall, the results confirm that the safety mechanisms functioned effectively in preventing overheating and electrical hazards.

Table 9. Mobility Test

Normal Force	Resistance due to Rolling Friction
F ≈171.5 N	Fr ≈ 68.6 N

Observations:

Table 9 illustrates the distinction between the normal force, which is the force required to lift Dryve, and the resistive force due to rolling friction, which determines the force needed to move the machine along a horizontal axis once caster wheels are attached. The amount of energy lost as a result of friction rather than being transformed into movement of the equipment wheels is known as "resistance." Thus, the equipment uses more energy to move when there is less friction since less energy is absorbed. Given that the machine has a mass of 17.5 kg, more than 171.5 N of force is required to lift it. This is calculated using the gravitational force equation:

$$F = mg$$

Gravitational Force Acting on Mass

On the other hand, the resistive force due to rolling friction determines the force a person must exert to initiate horizontal motion when the machine is equipped with caster wheels. Using the standard rolling friction equation, which is relevant to the caster wheel industry, where c is the coefficient of rolling friction and W is the weight, the researchers found that approximately 68.6 N of force is required to push or pull the equipment (Udegbunam, 2021).

$$Fr = cW$$

Resistance due to Rolling Friction

The substantial difference between these forces highlights the importance of caster wheels in significantly reducing the effort required to transport the machine.

IV. DISCUSSION

Based on the findings of the study, the Dryve drying machine demonstrated satisfactory performance across key parameters, including durability, efficiency, energy consumption, heat distribution, safety, and mobility. The machine showed no signs of damage across all experimental trials, confirming its durability under extended operating conditions.

Furthermore, results further indicated that optimal combinations of drying time and sample weight, particularly in Sets D and E, significantly improved drying efficiency and moisture reduction at a constant temperature of 110 °C. While energy consumption increased proportionally with longer operating durations, the machine maintained a consistent power rating, supporting its energy-efficient design. Heat distribution and moisture analysis revealed Set E as the most effective configuration, whereas safety evaluations confirmed the reliable operation of the thermostat and circuit breaker in preventing overheating and electrical hazards.

The integration of fiberglass insulation, a thermostat, a circuit breaker, and castor wheels enhanced the machine's overall functionality, safety, and mobility. Overall, the Dryve drying machine is proven to be a practical and efficient solution for faster organic fertilizer drying in residential applications, though further improvements in airflow, heat distribution, moisture control, and wheel design may further enhance its sustainability and performance.

Image 1 Final Product of the Study

Recommendations

This study examined the performance and operational efficiency of drying machines in accelerating the drying process of agricultural waste materials, leading to several recommendations for improving efficiency, effectiveness, and safety in organic fertilizer decomposition. Design and operational enhancements include incorporating mesh into drying racks to prevent small, dried materials from falling through, installing an automated timer to ensure consistent drying without manual monitoring, and using copper heat coils to improve heat transfer and temperature stability. Designing removable racks is also recommended to facilitate easier loading, cleaning, and maintenance, while adding a moisture-absorbing component may help reduce internal humidity and further enhance drying efficiency. In terms of energy efficiency and cost reduction, regular cleaning of heater coils, fans, and filters is advised to maintain optimal performance and prevent efficiency losses caused by dust accumulation. Additionally, integrating solar panels as a supplementary or alternative power source may significantly reduce energy consumption and operational costs, contributing to a more sustainable drying system.

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REPLICATION OF MEDI-SENSE BOX: DEVELOPMENT OF SENSOR-INTEGRATED MEDICINE BOX TO ADDRESS MEDICATION ADHERENCE (2025)

Authors: Renzo H. Ocampo, Althea Mae M. Abenojar, Rhico S. Ascaño, Mart Reden R. Blanco, Rhian B. Cablaida, Julianna Claire M. Caramto, Cathleen D. Hermosura, Maria Louisa A. Lim, Rianne Rafi M. Muesco, Ashey H. Vargas, John Bill V. Villasfer
School Year 2025-2026
Research Adviser: Virginia V. Papas

ABSTRACT

In today's fast-paced world, medication adherence is essential for achieving better health outcomes, and the improved Medi-Sense Box addresses this need by enhancing the effectiveness and efficiency of a sensor-integrated medicine reminder system. Building on previous research, the device uses an Arduino, an ultrasonic sensor, a servo motor, an LCD, a rechargeable battery, and a durable casing to ensure accurate timing, reliable alarms, and continuous operation. Compared to the earlier version, the improved model showed significant advancements in enclosure design, system efficiency, button layout, usability, accessibility, and cost-efficiency, as well as improved user understanding through the inclusion of a user manual. Testing confirmed rapid battery charging with long operating time, faster sensor response, audible alarms under varying noise conditions, and 100% time accuracy. Overall, the upgraded Medi-Sense Box demonstrated superior functionality, reliability, portability, and user convenience, making it a more effective tool for supporting proper medication adherence.

KEYWORDS: *Medi-Sense box, ultrasonic sensor, enhanced medication adherence, accuracy rate, assistive technology*

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I. Introduction

Medication adherence, defined as the extent to which patients take medications as prescribed, is essential for achieving positive health outcomes. Poor adherence, particularly among the elderly, individuals with memory impairments, and those with physical limitations, can lead to complications, worsening conditions, and increased healthcare costs. Studies such as Horvat et al. (2024) and Schwartz (2017) noted that many patients struggle to take medications correctly and consistently and that pillboxes can help support adherence.

Sensor-integrated medication boxes have been developed to address these challenges by providing organized compartments, reminders, and improved medication management. However, earlier prototypes, including the original Medi-Sense Box developed by Gamiao et al. (2025), had limitations related to usability and material quality. Building on previous systems, such as the one proposed by Zeidan et al. (2018), the current study aims to enhance the device by improving its physical design, portability, and user interface, including adding a larger, easy-to-press button to assist elderly users and those with limited hand strength.

The improved Sensor-Integrated Medicine Box incorporated pill-monitoring sensors, programmable alerts, and a microcontroller to support timely intake, track consumption, and generate usage histories. This study evaluated the effectiveness of these enhancements to assess their potential to reduce missed doses and improve overall treatment outcomes.

Statement of the Problem

This study aimed to replicate and improve the functionality of the Sensor-Integrated Medicine Box (Medi-Sense) to guarantee the needs of its target users and enhance medication adherence.

Specifically, the study sought to address the following questions:

1. What are the specific improvements that can affect the following aspects of the Medi-Sense Box compared to the previous material:

1.1. Physical interface improvement: use of thicker acrylic sheets for a lighter, more durable, and cost-efficient design,

1.2. Button design enhancement: replacement of small tactile switches with larger, easy-press buttons,

1.3. Power supply upgrade: integration of rechargeable or replaceable battery system, and

1.4. User support material: inclusion of a clear and simple user manual for guidance?

2. How do the applied improvements affect the following:

2.1. Comparison of overall performance,

2.2. Accessibility,

2.3. Cost-efficiency, and

2.4. Usability of the Medi-Sense Box compared to the initial prototype in terms of:

2.4.1 Sensor Response Time,

2.4.2 Alarm Audibility, and

2.4.3 Time Alarm Accuracy?

3. Based on the results, what conclusions can be made?

Scope and Limitation

The study centers on the development of a physical interface and the evaluation of the Medi-Sense Box's features and its ability to remind individuals to take their medication on time with ease of use. The study was limited to assessing the effectiveness of the Medi-Sense Box for pill-based medication, excluding different types of medicine. It focused on how well the device reminded users to take their medication at the correct time. The testing was conducted within Camp Vicente Lim.

II. METHODOLOGY

This section describes the methodology used in the study, including the conceptual framework, research methodology flowchart, system diagrams, materials costing, and Arduino IDE codes. These elements explain how the system was designed, assembled, and implemented to achieve the study's objectives.

Conceptual Framework of the Study

The conceptual framework for this replicated study is based on the Input–Process–Output (IPO) model, which provides a structured approach for understanding the development of the Medi-Sense Box. This model organizes the project into three key stages: defined inputs, systematic processes, and the resulting functional output.

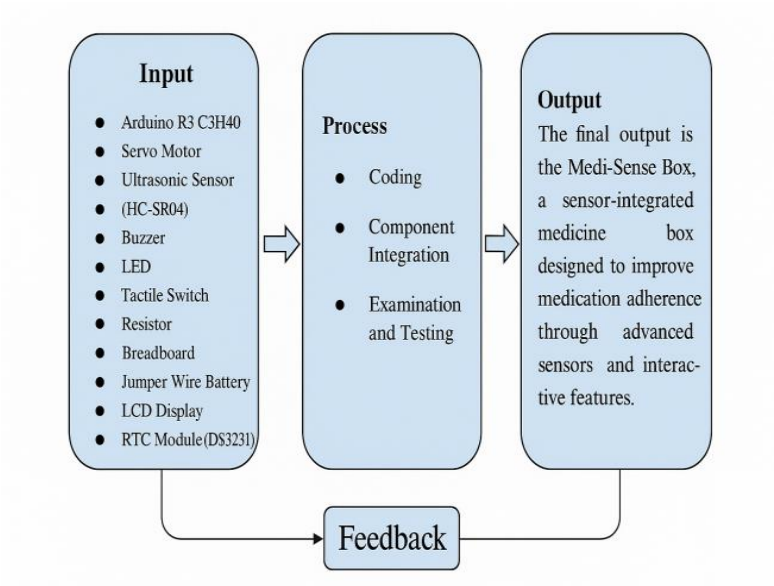

Figure 1. Input-Process-Output Method (IPO Method)

The product is the Medi-Sense Box, a sensor-enabled medicine box. Figure 1 depicts the thought process, beginning with input materials like the Arduino, servo motors, ultrasonic sensors, rechargeable battery, and other electrical components from their assembly, coding, and testing to the product of a working Medi-Sense Box that will encourage medication compliance through increased readability, better structure, and interactive user-friendly functions. This flowchart clearly shows the systematic approach used in constructing the device, emphasizing the stages of planning, integration, and testing necessary to develop a good, efficient product.

Research Methodology Flowchart

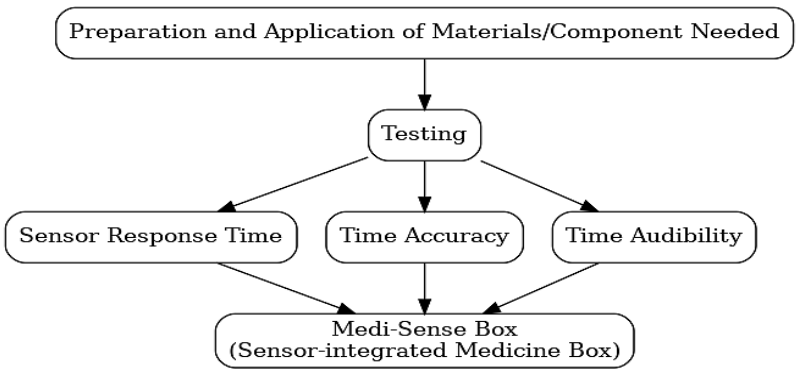

Figure 2. Research Methodology Flowchart

Figure 2 presents the Sensor-Integrated Medicine Box, named Medi-Sense, which was subjected to testing with respect to (1) Sensor Response Time, (2) Time Accuracy, and (3) Time Audibility during its application. This blueprint contributes to the product by clearly outlining the placement and interaction of Medi-Sense's components, enabling consistent assembly and accurate testing. It ensures that the device's sensor response time, time accuracy, and time audibility can be evaluated reliably, thereby supporting the overall effectiveness and reliability of the system.

Wiring Diagram of the System

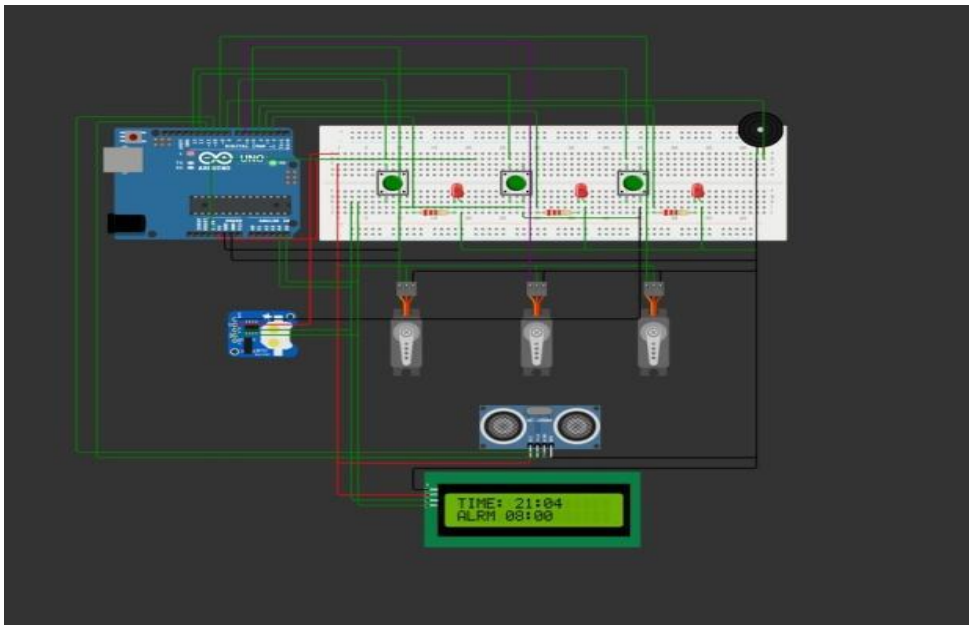

Figure 3. Wiring Diagram of the System

Figure 3 illustrates the complete Arduino-based alarm and automation system, with the Arduino UNO serving as the main controller that supplies power and manages all components. The RTC module and 16×2 LCD share I2C lines to display accurate time and alarm status, while LEDs indicate system states. Push buttons enable time setting, system control, and alert acknowledgment, and a buzzer provides audible alarms. Servos connected to PWM pins perform mechanical actions, while the HC-SR04 ultrasonic sensor detects distance or motion. All components share a common ground, ensuring reliable and coordinated system operation.

Pictorial System Diagram

Figure 4. Pictorial System Diagram

Figure 4 presents the various electronic and structural components assembled to create the sensor-integrated medicine box. These include the Arduino Uno, servo motor, HC-SR04 ultrasonic sensor, buzzer, LEDs, tactile switch, resistors, breadboard, jumper wires, power source, LCD display, DS3231 RTC module, battery, and acrylic sheets. Together, these materials enable the device to incorporate technological functions into a conventional medicine box, thereby enhancing patient medication adherence.

III. RESULTS

The findings, analysis, and interpretation of the information acquired from the device's numerous tests, experiments, and assessments are presented in this part. A description of the results from several aspects of the study's goals is also included in this section.

Table 1. Comparison of Enclosure Materials for the Medi-Sense Box

Criteria	Previous Acrylic Sheets	Quality Acrylic Sheets	Observation
Acrylic Sheet Size	2x2 mm	3x3 mm	Better structural support
Weight	Light	Moderate	Improved stability
Thickness	Thin	Thick	Increases rigidity
Durability	Moderate	High	Better durability and impact resistance
Portability	Poor	Good	Easier to carry
Overall Design Efficiency	Low	High	Improved design

Table 1 highlights the improved enclosure design of the Medi-Sense Box through the use of high-quality acrylic sheets. Increasing the sheet size and thickness enhanced structural support, impact resistance, and overall durability, while improving portability from poor to good despite a slight increase in weight that contributed to better stability. As a result, overall design efficiency improved from low to high, effectively addressing previous design limitations. These enhancements are supported by Han et al. (2024), who emphasized acrylic's durability and cost-efficiency, and Seo et al. (2023), who underscored its safety, design flexibility, and user-friendly qualities in medical applications.

Table 2. Comparison and Test Results of Button Designs

Criteria	Previous small tactile switches used in the Medi-Sense Box	Current easy-press, slightly larger-sized buttons of the Medi-Sense Box	Observation
Button Size	6x6x4.3 mm	6x6x6 mm	Larger button easier to locate
Required Press Force	Medium	Low	Less force needed
Ease of Pressing	Moderate	Easy	Improved usability
Comfort	Poor	Good	Less finger strain
Overall Usability	Poor	Excellent	Enhanced Design

Table 2 indicates the comparison and test results of button design. The researchers found that the original small buttons (6×6×4.3 mm) were hard to use. They were difficult to find and required too much pressure to press, which made the device uncomfortable for the user. To fix this, we switched to slightly taller, easier-to-press buttons (6×6×6 mm). Although the size change was small, it made a huge difference. The device is now much more pleasant and user-friendly. By increasing the button height to 6 mm, the design addressed both dimensions of the Liao et al. (2020) study: the taller profile provided a clearer visual cue for the user to find the controls, while the reduced pressure requirement improved the tactile interaction. Because of this change, the usability rating improved from "Poor" to "Excellent."

Table 3. Rechargeable Battery Test

Battery	Battery Life	Charging Duration	Observation
Lithium Polymer Battery	11 hrs and 25 mins	2 hrs and 34 mins	Efficient charging speed with stable endurance
	12 hrs	2 hrs and 35 mins	Consistent performance and charging reliability
	3 days (Power Saving Mode)	2 hrs and 35 mins	Significantly extended battery life with rapid recharging

Table 3 outlines test results for a lithium polymer battery as part of a power supply upgrade plan focused on integrating rechargeable or replaceable battery systems. The first set of measurements demonstrates strong performance, with the battery delivering a total runtime of 11 hours and 25 minutes when fully charged and requiring only 2 hours and 34 minutes to reach full capacity from an empty state. This observation of "rapid charging endurance" indicates that the battery not only supports fast charging but also maintains reliable functionality and longevity under such conditions. These results are consistent with the findings of Liang et al. (2019), who emphasized that rechargeable batteries serve as the primary energy source of portable electronic devices and play a critical role in sustaining performance stability, particularly in applications where continuous operation and minimal downtime are essential.

Table 4. Comparison of User Support Materials for the Medi-Sense Box

Criteria	Previous Version (No Manual)	Current Version (With User Manual)	Observation
Availability of Manual	None	Printed Manual Included	User guidance is now provided
Ease of Understanding	Difficult	Easy	Instructions are clear and simple
Setup Time	Long	Short	Users can set up the device faster
Error Rate During Use	High	Low	Fewer mistakes occur with guidance
Learning Time	Long	Short	Manual shortens the time it takes to learn
Overall Usability	Poor	Good	Usability significantly improved

Table 4 shows the limitations of the previous device by providing a structured and easy-to-use manual. The manual was designed using simple language and visual cues to guide users in device setup and medication reminders. This helps to improve and make the device easier to understand, reduce user errors, and shorten the setup and learning time, particularly for elderly people who have difficulty interpreting medical instructions without the guidance of others. This is supported by the study of Berthenet et al. (2016). According to their study among elderly outpatients, 50 of 76 tested pharmaceutical pictograms reached over 67% comprehension, validating that adding a guidance manual and pictogram could increase medication adherence and reduce errors.

Table 5. Comparison of Overall Performance of the Medi-Sense Box

Performance Indicator	Initial Prototype	Improved Medi-Sense Box	Observation
Sensor Response Time	Moderate	Fast	Improved responsiveness
Alert Accuracy	Moderate	High	More reliable alerts
System Reliability	Moderate	High	Fewer system errors
Power Stability	Low	High	Consistent operation
Overall Performance	Fair	Excellent	Performance significantly improved

Table 5 shows that the new Medi-Sense prototype is much better than the original one. The sensors now respond faster, and the alerts are much more accurate with fewer errors. Power stability moved from "Low" to "High," which keeps the device running without stopping. Because of this major improvement, the overall performance jumped from "fair" to "excellent," proving that the new Medi-Sense is more durable, dependable, and stronger. According to Saraswathi et al. (2023), a smart medicine box with sensors could significantly improve medication compliance; this proves that the Medi-Sense can really bring changes in the users.

Table 6. Accessibility Comparison of the Medi-Sense Box

Accessibility Factor	Initial Prototype	Improved Medi-Sense Box	Observation
Button Size	Small	Medium	Easier to press
Ease of Handling	Difficult	Easy	Improved portability
User Guidance	None	With manual	Better user understanding
Time of Learning	Slow	Fast	Faster adaptation
Accessibility Level	Low	High	Accessibility enhanced

Table 6 shows that the improved Medi-Sense Box enhanced usability and accessibility by upgrading from small to medium-sized buttons, making the device easier to press and handle. The addition of a user manual significantly reduced learning time and improved user understanding, while improvements in design increased portability and overall accessibility from low to high. Designed for users with limited motor skills and minimal technical knowledge, its lightweight acrylic casing supports ease of handling and independent use, particularly among elderly users. These design features are supported by Horvat et al. (2024), who emphasized minimizing physical and cognitive barriers, and Saraswathi et al. (2023), who highlighted the role of sensor-based automation and clear guidance in improving accessibility and medication adherence.

Table 7. Cost-Efficiency Comparison of the Medi-Sense Box

Cost Factor	Initial Prototype	Improved Medi-Sense Box	Observation
Enclosure Material	Lower	High	Improved stability
Battery Replacement	Not rechargeable	Rechargeable	Reduced recurring cost
Overall Cost-Efficiency	Low	Moderate	More economical over time

Table 7 compares the cost-efficiency of the initial prototype and the improved Medi-Sense Box. Although the improved version used higher-quality materials and required a higher initial cost, its enhanced durability and use of a rechargeable battery significantly reduced long-term expenses. In contrast, the initial prototype relied on a non-rechargeable battery, resulting in frequent replacements and higher recurring costs. Overall, the improved Medi-Sense Box demonstrated high cost-efficiency, consistent with Schwartz (2017), who emphasized that durable assistive medication devices reduce costly medication errors and support long-term savings.

Table 8. First Sensor Response Time Test

Sensor	Trial No.	Expected Response Time	Actual Response Time	Difference	Observation
Ultrasonic Sensor (HC-SR04)	1	1 second	0.42 seconds	0.58	Faster than expected response
	2	1 second	0.46 seconds	0.54	Faster than expected response
	3	1 second	0.29 seconds	0.71	Faster than expected response

Table 8 shows that in the first sensor response time test, Trial 1 recorded an actual response time of 0.42 seconds, followed by 0.46 seconds in Trial 2 and 0.29 seconds in Trial 3. Each actual response time responded faster than the expected response time of one second in all trials. This shows that the ultrasonic sensor (HC-SR04) was able to detect user interaction and support timely system actions.

Table 9. Second Sensor Response Time Test

Sensor	Trial No.	Expected Response Time	Actual Response Time	Difference	Observation
Ultrasonic Sensor (HC-SR04)	1	1 second	1 second	0	Matched expectation
	2	1 second	0.44 seconds	0.56	Faster than expected response
	3	1 second	0.67 seconds	0.33	Fast than expected response

Table 9, which is the second sensor response time test, trial 1 met the expected response time of one second, while trial 2 and trial 3 responded faster at 0.44 and 0.67 seconds, respectively. The results indicate consistent sensor performance under repeated testing conditions.

Table 10. First Alarm Audibility Test (Lower Environmental Noise)

Trial No.	Distance (Meter)	Environmental Noise (Decibel)	Alarm Sound Level (Decibel)	Observation
1	1 m	35dB	67 dB	The alarm was loud and distinctly heard.
2	3 m	36 dB	58 dB	The alarm was audible, but marginally decreased as a distance grew farther away.
3	5 m	43 dB	52 dB	The alarm was weak but still audible.

Table 10 presents the results of the alarm audibility test conducted in a low-noise home environment. At 1 meter, the alarm sound was clearly distinguishable from environmental noise, while at 3 meters it remained audible despite a slight decrease in clarity. At 5 meters, although the alarm intensity further decreased and background noise increased, the alarm was still audible. Overall, the findings indicate that alarm audibility decreases as distance increases, even under low environmental noise conditions.

Table 11. Second Alarm Audibility Test (Higher Environmental Noise)

Trial No.	Distance (Meter)	Environmental Noise (Decibel)	Alarm Sound Level (Decibel)	Observation
1	1 m	44 dB	55 dB	The alarm was sounded a little louder.
2	3 m	33 dB	53 dB	The alarm was audible, but weaker as a result of the elevated environmental sound.
3	5 m	42 dB	51 dB	The alarm was audible, but less clear because of elevated distance.

Table 11 presents the results of the alarm audibility test conducted under higher environmental noise conditions. At 1 meter, the alarm remained loud and clearly distinguishable from background noise, while at 3 meters it was still audible but perceived as weaker due to increased distance. At 5 meters, although the alarm sound level further decreased and environmental noise increased, the alarm remained audible but less clear. Overall, the results

demonstrate that alarm audibility decreases as the distance from the device increases, regardless of variations in environmental noise levels.

Table 12. Time Accuracy Test

Trial No.	Schedules Time	Actual Activation Time	Time Difference	Classification	Remarks
1	6:00 AM	6:00 AM	0	TP (True Positive)	Accurate
2	10:00 AM	10:00 AM	0	TP (True Positive)	Accurate
3	2:00 PM	2:00 PM	0	TP (True Positive)	Accurate
4	No Reminder	No Alarm	N/A	TN (True Negative)	Correctly Silent
Accuracy	100%				

Table 12 shows the Time Accuracy Test. The sample span is around 4 hours, and the scheduled times are 6:00 AM, 10:00 AM, and 2:00 PM. All of the tests accurately activated at the scheduled times with no time difference, which concluded as True Positive (TP) classifications. For the last test, there was no scheduled reminder; therefore, no alarm rang, and no time difference was available. This resulted in a True Negative (TN) classification, indicating that the system was correctly silent. Overall, all tests accurately depicted time accuracy with no allowances, which resulted in a 100% Time Accuracy Test.

IV. DISCUSSION

The Medi-sense Box was successfully developed to support proper medication management, particularly for elderly users and individuals with chronic illnesses. It is integrated with an Arduino-based sensor system and an LCD display. Similar to the previous studies, the device incorporates an HC-SR04 ultrasonic sensor to detect user presence, an accurate alarm schedule using RTC (Real-Time Clock), and audible alarms under various environmental conditions.

Building on the recommendations of previous researchers, this study introduced several key improvements, including a structured, easy-to-use manual and rechargeable batteries and an acrylic sheet as the base material. These enhancements improved usability, portability, and durability while also making the device cost-efficient.

For instance, the Medi-sense box is intended to help patients adhere to their medication regimens and improve their healthy lifestyle. This is especially important for elderly patients and patients who have trouble taking their medications on time. This ensures and prioritizes the patient's well-being. It is a user-friendly medication box that includes an understandable manual and an accessible interface with sensors and an audible alert to help prevent missed doses. Additionally, many people will have access to a portable medicine box that they can bring with them wherever they go, especially while they're not at home. Particularly for elderly patients and others with hearing difficulties, the unique medicine box has improved sound clarity.

Recommendations

To further enhance the functionality and usability of the Medi-Sense Box, several improvements are recommended based on the study's results. The use of 3D printing may be explored to improve the device casing's durability and overall design. Enhancing the system's mobility and automation is also suggested to promote easier and more efficient operation. Additionally, extending the buzzer alarm duration may improve alert effectiveness and ensure timely user response. Redesigning the physical interface into a more organized and visually appealing layout could further enhance usability and user experience. Lastly, testing the device with actual participants is highly recommended to evaluate its performance, reliability, and overall effectiveness.

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VISION

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