Republic of the Philippines
Department of Education
REGION IV – A CALABARZON
SCHOOLS DIVISION OF BATANGAS
ANSELMO A. SANDOVAL MEMORIAL NATIONAL HIGH SCHOOL
P. BALIBAGUHAN, MABINI, BATANGAS

Bottle for a Pen: Via Automated Plastic Bottle Vending Machine

A Thesis

Presented to

The Faculty of the Senior High School Department

ANSELMO A. SANDOVAL MEMORIAL NATIONAL HIGH SCHOOL

P. Balibaguhan, Mabini Batangas

In Partial Fulfillment

of the Requirements for

Inquiries, Investigations, and Immersion

By:

Jaso, Jherwin S.
Gonda, Andrew Jeoyam M.
Maala, Andie Luc C.
Manongsong, Paul Francis D.
Ramos, Ralph Jareez D.
Reyes, John Justin B.
Sarmiento, Mikel Jazle D.
Sombilon, John Joren V.
Dolor, Maria Rosalyn S.
Gunio, Rica Jhane J.
Matira, Christine Joy M.
Presto, Aileen V.

March 2025

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

TABLE OF CONTENTS

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

LIST OF TABLES

Tables **Page**

Chapter IV

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

LIST OF FIGURES

Page

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

APPROVAL SHEET

This thesis entitled **"BOTTLE FOR A PEN: Via AUTOMATED PLASTIC BOTTLE VENDING MACHINE"** prepared and submitted by GROUP 2 GRADE 12 - AMBER RESEARCHERS has been approved and accepted as partial fulfillment of the requirements in Inquiries, Investigations, and Immersion of Information and Communication Technology (ICT).

DR. MARILOU A. ESCALONA
Research Adviser

Accepted and approved by the committee on Poster Examination with a grade of _____

PANEL OF EXAMINERS

CARMELO C. CARPIO
Panelist 1

DR. LISA M. GARCIA
Panelist 2

SHIRLYN V. MORENO
Panelist 3

Accepted and approved in partial fulfillment of the requirements for the strand Information and Communication Technology (ICT) in the subject Inquiries, Investigations, and Immersion.

JONEL F. PALUBON
SHS Research Coordinator

WILFREDO M. DAKILA
Principal IV

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

ABSTRACT

This research paper, "Bottle for a Pen: Via Automated Plastic Bottle Vending Machine", investigates the development and implementation of an automated plastic bottle vending machine designed to promote recycling habits and environmental awareness among students in Anselmo A. Sandoval Memorial National High School. The study aims to assess the machine's effectiveness in encouraging proper disposal of plastic bottles and its overall impact on the school's sustainability initiative.

Through quantitative research method, the study evaluates the students' engagement with the vending machine, their recycling behaviors, and their attitudes towards environmental conservation. Data collected from survey provide insights into the machine's usage, its benefits, and areas for improvement.

The findings indicate a positive correlation between the presence of the vending machine and an increase in recycling activities among students. Additionally, the study highlights the importance of integrating innovative solution in educational settings to respond environmental responsibility and sustainable practices. The paper concludes with recommendations for further enhancing the vending machine's functionality and expanding its implementation to other educational institutions.

This research contributes to the ongoing efforts to address plastic waste management and underscores the role of educational institutions in promoting environmental stewardship.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

ACKNOWLEDGEMENT

The completion of this endeavor could not have been possible to come in reality without the participation and assistance of people who support and contribute to the fulfillment of this study. The researchers would like to extend our sincerest acknowledgment, appreciation, and gratitude to the following:

Dr. Marilou A. Escalona, our Thesis Adviser for her invaluable guidance and unwavering support throughout the research process. Her expertise and encouragement have been instrumental in shaping the outcome of our study.

Mrs. Araceli S. Anyayahan, for generously allowing us to utilize her printer equipment, which enabled us to produce high-quality materials for our research. Their support has been indispensable to the success of this project.

Carmelo C. Carpio, Dr. Lisa M. Garcia, Shirlyn V. Moreno, our dear research panelists for their constructive feedback and insights to improve our study, which has enriched our research and contributed to its overall quality. Their expertise and valuable input have been greatly appreciated.

Our Parents, for their unwavering support and encouragement to every one of us. Their belief in our abilities and constant encouragement has provided us with the motivation to persevere through challenges and see this research to its completion.

Our Respondents, for honestly answering the research questions and for cooperatively participating in fulfilling this endeavor. Above all, our Almighty God, the source of everything, for giving us guidance and courage to face all the difficulties and obstacles throughout the process of making this research come to reality.

We sincerely acknowledge all those who have generously offered their and guidance throughout this journey. Thank you very much.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

DEDICATION

We, the researchers, **Jherwin S. Jaso, Andrew Jeoyam M. Gonda, Andie Luc C. Maala, Paul Francis D. Manongsong, Ralph Jareez D. Ramos, John Justin B. Reyes, Mikel Jazle D. Sarmiento, John Joren V. Sombilon, Maria Rosalyn S. Dolor, Rica Jhane J. Gunio, Christine Joy M. Matira, and Aileen V. Presto** sincerely dedicate this research study to the people who greatly support, encourage, and inspire us in fulfilling this endeavor.

First, to our beloved family, who have been the source of our courage, motivation, and inspiration in fulfilling this endeavor. Their unwavering moral, spiritual, emotional, and financial support has been invaluable. Without their love and assistance, this research would not have been possible.

Next, to our friends, who served as our supporters throughout the process of conducting our study. Their encouragement and companionship have been essential in helping us successfully fulfill this study.

Then, to everyone who actively participates in recycling initiatives and advocates for sustainable practices. Your dedication to environmental stewardship has been the primary inspiration for conducting this study.

And lastly, we dedicate this research paper to the Almighty God, who gives us strength, guidance, competency, protection, and passion. We dedicate all of this to you.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

CHAPTER I

INTRODUCTION

This chapter presents the introduction of the study. It includes the background of the study, statement of the problem, objective of the study, significance of the study, scope and limitation of the study and definition of terms.

Background of the Study

In today's fast paced world, the population increases more often which includes the solid wastes. Wastes that can be found discarded across the fields of cities, village, etc. Due to irresponsible disposal of waste, it leads to pollution which harms mother nature itself. There are practices of proper management of disposal namely Reuse, Reduce, and Recycle which is effective yet ineffective at the same time. We aim to explore the innovative concept of exchanging a reusable bottle for a pen through an automated vending machine system. Unlike a conventional vending machine which is a kind of money-operated machine that dispense goods automatically such snacks, beverages, alcohol, and other consumer products that solely accept a certain amount of money or credit card upon being inserted into the vending machine to get the desired product of the customer.

Bottle for a pen via automated vending machine using Arduino Uno a popular low-cost, flexible, and easy to use programmable open-source micro-controller board that act as the brain of the vending machine. Utilizing an Arduino micro-controller, the machine orchestrates interactions between various components, including sensors for detecting bottle insertion. A laptop for programming to run an Arduino code to control the entire process and lastly, a plywood that will serve as the main body of the automated vending machine that will act as a protective barrier to the internal components. The vending machine's design incorporates a user-friendly interface that guides users through the

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

exchange process, this system promotes recycling by allowing users to insert plastic bottles as payment for pens, reducing plastic waste while meeting essential stationery needs.

The study investigates an innovative automated vending machine designed to dispense pens in exchange for plastic bottles. This dual exchange system not only facilitates the writing instruments but also promotes environmental sustainability by encouraging the recycling of plastic waste while addressing challenges such as waste management and resource management. Our primary focused of this study is to develop, and evaluate the effectiveness of an automated plastic bottle vending machine at Anselmo A. Sandoval Memorial National High School (AASMNHS) to assess the technical feasibility, reliability, and ease of use of the vending machine, ensuring its practicality as a solution.

According to Dacay (2020), At the onset of 2010 onwards, environmental protection stands in a precarious position. In the Philippines, about 35,580 tons of garbage is generated everyday. On the average, each person in the country produces about 0.5 kg and 0.3 kg of garbage every day both in the urban and rural areas. This study aims to reduce plastic waste bottles through dispensing usable products (ballpoint pen and bundles of newsprint) in exchange of the disposed plastic bottles. VendoBin is a combination of garbage bin and vending machine. This study aims to develop a habit of proper disposing of plastic bottles through rewards system. VendoBin were developed using Raspberry Pi 3, single-chip computer used in controlling the components.

According to Deena (2020), In this 21st century as the amount of waste generated is increasing but the landfill space for disposal is limited, recycling is an important approach to manage the waste effectively. The major contribution to the waste generated is plastic which are thrown away after their usage. We aim to build a Reverse Vending Machine for collecting plastic bottles with reward

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

feature. The technology used for identifying plastic bottles is image processing. Once the number of bottles are identified depositor can claim the points by entering a unique ID and the accumulated points can be used to generate promo code for online shopping. The user and authority can keep track of their details by maintaining an account in the application software developed. Once the machine at a specified location is filled, this could be notified to the authority via messaging through the application.

Statement of the Problem

This study aimed to design and evaluate the Bottle for a Pen: Via Automated Plastic Bottle Vending Machine among Anselmo A. Sandoval Memorial National High School S.Y 2024-2025.

Specifically, this study sought to answer the following questions:

1. How may automated bottle vending machine be described in terms of:
   1.1 design
   1.2 usability
2. What is the level performance of automated vending machine in terms of:
   2.1 speed;
   2.2 functionality;
   2.3 durability; and
   2.4 location flexibility?
3. How efficient is the automated bottle vending machine in terms of:
   3.1 operation;
   3.2 capacity/volume, and
   3.3 client satisfaction?
4. Based on the findings, what action may be proposed to enhance the automated plastic bottle vending machine?

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Objectives of the Study

The main objective of this study is to design and evaluate the effectiveness of the Bottle for a Pen: Via Automated Plastic Bottle Vending Machine at Anselmo A. Sandoval Memorial National High School for the school year 2024-2025.

Specifically, this study aims to:

1. Describe the automated bottle vending machine in terms of:
    1.1. design
    1.2. usability
2. Assess the level of performance of the automated vending machine in terms of:
    2.1. speed ;
    2.2. functionality;
    2.3. durability; and
    2.4. location flexibility?
3. Determine the efficiency of the automated bottle vending machine in terms of:
    3.1. operation;
    3.2. capacity/volume; and
    3.3. client satisfaction?
4. Proposed action based on the findings to enhance the efficiency of the automated bottle vending machine.

Scope and Limitation

This study focuses on the development, implementation, and evaluation of an automated plastic bottle vending machine at Anselmo A. Sandoval Memorial National High School (AASMNHS). The machine is designed to encourage proper waste disposal and recycling practices within the school community by

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

exchanging plastic bottles for pens. The primary goal is to promote environmental awareness, sustainability, and responsible behavior among students, teachers, and staff.

The scope of the study is confined to the premises of AASMNHS and targets its internal community. The vending machine is programmed to accept standard-sized plastic bottles, commonly used for beverages, as the recyclable material. As an incentive, the machine dispenses pens, chosen for their practical use in the academic environment. The study includes the technical design and functionality of the vending machine, and assessment of its effectiveness in promoting recycling habits.

The study is delimited by several factors. It is limited to AASMNHS and does not extend to other schools or communities. The vending machine is restricted to processing plastic bottles only and does not accept other types of waste, such as aluminum cans or paper. Rewards are exclusively limited to pens and do not include any other items. Furthermore, the study does not cover the downstream recycling process, such as the transportation or reprocessing of the collected bottles, as it focuses solely on the behavioral aspect of waste management and the system's operation within the school.

Significance of the Study

The study on the implementation of an automated plastic bottle vending machine that dispenses pens in exchange for recycled bottles holds significant value for students, teachers, and future researchers.

To the students, it inculcates environmental awareness and responsibility by teaching them the importance of recycling and its role in reducing plastic waste. The reward system, where students receive pens—a useful academic tool—motivates them to actively participate in recycling initiatives. This also offers a practical learning opportunity, connecting environmental concepts with

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

real-world applications and instilling positive habits that encourage sustainability in their daily lives.

To the teachers, the vending machine serves as an educational tool for promoting sustainability. It provides a hands-on demonstration of recycling concepts, making lessons more engaging and impact. The initiative fosters a culture of teamwork and environmental stewardship within the school community. Additionally, by reducing plastic waste, the project enhances the learning environment, creating a cleaner and more organized campus conducive to effective teaching and learning.

To the future researchers, the study lays a foundation for further exploration into similar initiatives. It provides valuable insights and data on the efficiency, scalability, and behavioral impacts of such systems. The project can inspire innovative solutions to environmental challenges and contribute to the growing body of knowledge on sustainability and waste management. Furthermore, it highlights the potential for interdisciplinary approaches to address ecological issues effectively.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

CHAPTER II

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents the related literature of the studies that helped shape this study. It includes related literature, related studies, synthesis, conceptual framework, and definition and terms.

Related Literature

Designing Vending Machine

According to Mohan (2024), in recent years, the integration of technology into various aspects of daily life has become increasingly prevalent, revolutionizing traditional systems and processes. One such area experiencing significant innovation is vending machines, where automation and customization are enhancing user experiences and efficiency. This research focuses on the design and implementation of an Arduino UNO-based automatic ballpen vending machine equipped with a unique exchange system. Unlike conventional vending machines that solely accept coins or banknotes, this innovative system allows users to exchange both coins and plastic bottles for the desired product, thereby promoting environmental sustainability and providing added convenience. The Arduino UNO micro-controller serves as the brain of the vending machine, orchestrating the interaction between various components such as sensors, actuators, and the vending mechanism. Leveraging the versatility and accessibility of the Arduino platform, our design aims to deliver a cost-effective and adaptable solution suitable for diverse settings, including educational institutions, offices, and public spaces.

Demand For Plastic Waste

According to Daegi (2021), plastics have multiple applications in disposable products, high-end technology parts, etc., owing to their functionality and manufacturing flexibility. However, their increased use has increased the

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

global proportion of plastic wastes, which creates a serious environmental issue, thereby, creating a demand for plastic waste management techniques. Improving the efficiency of resource recovery by appropriate sorting and collection systems is necessary for successful plastic recycling. Therefore, this study proposed a three-step optimization process of a reverse vending machine (RVM), a small automatic recyclable waste sorter/collector system, for acquiring an optimal design and enhanced efficiency.

Advancements in Vending Machine Technology

According to Ratnasria and Sharmilan (2024), review the evolution of vending machines, highlighting the shift from non-IoT to IoT-based systems. IoT-enabled vending machines offer cashless payment options, real-time data monitoring, and improved customer satisfaction. These advancements make vending machines more efficient and user-friendly, addressing issues like inventory management and hygiene. The integration of IoT and machine learning technologies is essential for meeting modern consumer preferences and enhancing the overall vending experience

Digital Transformation of Vending Machines

According to Thete (2024), analyze the transition from traditional to digital vending machine systems. The study emphasizes the benefits of IoT-enabled vending machines, such as remote inventory monitoring, real-time data analysis, and enhanced security through RFID and UPI payment systems. These smart vending machines optimize product availability, reduce operational costs, and improve customer satisfaction. The digital transformation of vending machines is revolutionizing the industry by providing a more convenient and secure shopping experience.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Plastic Bottle Waste Is a Major Concern

According to Huma (2022), the management of the abundant amount of used plastic bottle waste is a major concern nowadays, because it is a major contributor to landfills and overburdens waste processing facilities. Once disposed of, plastic can take centuries to break down, hence, recycling not only manages the waste efficiently, but it reduces the environmental impact and creates economic opportunities, as well. An incentive-based Reverse Vending machine (RVM) is an effective way to involve the general public in the management of plastic waste. The existing solutions are either very expensive, from a computation and cost perspective, or they lack the robustness and durability necessary for deployment.

Important Approach To Manage The Waste Effectively

According to Deena (2020), in this 21st century as the amount of waste generated is increasing but the landfill space for disposal is limited, recycling is an important approach to manage the waste effectively. The major contribution to the waste generated is plastic which are thrown away after their usage. We aim to build a Reverse Vending Machine for collecting plastic bottles with reward feature. The technology used for identifying plastic bottles is image processing. Once the number of bottles are identified depositor can claim the points by entering a unique ID and the accumulated points can be used to generate promo code for online shopping.

Overcome The Problem Of Waste

According to Baribad (2024), waste has become one of the most serious global issues today. Recycling is one of the important ways to manage waste properly. Reverse Vending Machine is an innovative idea that inculcates the habit of recycling waste materials. To overcome the problem of waste, Plastic2Fantastic: Reverse Vending Machine for Plastic Bottles was developed

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

as a machine that accepts and deposits empty plastic beverage containers in exchange for money. The machine was constructed from aluminum and implemented in a standard trash bin equipped with Raspberry Pi 3B, 7-inch Touch Screen LCD, RFID reader, coin hopper, ultrasonic sensor, capacities proximity sensor, inductive proximity sensor, IR proximity sensor, and M995sg servo motor.

Related Studies

Reducing The Volume Of Waste

According to Kumar (2020), plastic is a non-biodegradable waste. It is noted that, around 60 to 90 per cent of waste generated is due to plastic debris. Plastic usage has become rampant in industries across the world as it is the most common and adaptable material for manufacturing and packaging their products. They have become an integral part of our lives that they cannot be easily replaced. This paper aims at recycling plastic bottles into a useful product. It involves the process of crushing, melting and moulding of used plastic bottles.

Innovative Waste Solutions

According to Richest (2024), the country faces significant waste management challenges due to rapid urbanization and growing populations. Innovative solutions like waste-to-energy technologies, material recovery facilities, and composting initiatives are being implemented to address these issues. These approaches not only reduce landfill waste but also create job opportunities and promote sustainable practices. The Philippines is becoming a leader in the recycling revolution through these multifaceted strategies.

Smart Waste Management Technologies

According to Haulla (2022), discusses the importance of smart waste management in reducing environmental impact. Technologies like smart waste bins, which use AI and sensors to identify, sort, and compress waste, are

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

revolutionizing the industry. These innovations optimize garbage collection routes and schedules, reducing overall waste levels. Smart waste management is essential for conserving resources and minimizing greenhouse gas emissions.

Plastic Is Non-Biodegradable

According to Noor (2021), plastic bottle takes time to be decomposed because plastic is non-biodegradable. Therefore, it is essential that plastic should be recycled. The process of recycling starts with collecting plastic bottles. Then, they must be sorted in different categories. In order to form a pallet, the component must be crushed or melted. Therefore, the plastic bottle must be cut into smaller pieces appropriate with the machine condition before transferred to the further process, such as injection molding. Impact system and rotary system are two common system used in the crushing machine.

Development Of Innovative Solutions

According to Mohamed (2024), the growing concern over plastic pollution and its adverse impact on the environment has prompted the development of innovative solutions to address the issue effectively. Improper disposal of plastic bottles leads to environmental pollution. This paper presents the design and implementation of a prototype of smart plastic bottle recycle machine, integrating the Internet of Things (IoT). The Arduino board is used to control the machine. The smart plastic bottle recycling machine incorporates the ESP8266 and a Wi-Fi enabled system-on-chip (SoC) module used to develop IoT embedded applications. The utilization of IoT technology enables seamless real-time data transmission, allowing for efficient communication with the central system and simpliying remote monitoring and management processes.

Emerging Smart Waste Technologies

According to Romuno (2023), highlights six emerging smart waste management technologies for 2025. These technologies, such as Pello, monitor

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

trash levels in real-time and provide data on dumpster contents and location. By streamlining waste collection and improving sustainability, these innovations help businesses reduce their environmental impact. The integration of IoT and automation in waste management is crucial for building a more sustainable industry.

Smart Recycling Solutions

According to Johnson (2022), explores the development of smart recycling solutions using advanced technologies like IoT and AI. The study discusses how these technologies can improve waste management by providing real-time data on waste levels, optimizing collection routes, and enhancing the sorting process. The implementation of smart recycling solutions can lead to more efficient waste management, reduced environmental impact, and cost savings for municipalities. The research emphasizes the potential of smart technologies to transform the recycling industry.

Synthesis

Both Mohan (2024) and Daegi (2021) integrate technology into vending machines to enhance functionality and promote sustainability. Mohan's automatic ballpen vending machine allows users to exchange coins and plastic bottles for ballpens, focusing on user convenience. Daegi's reverse vending machine aims to optimize plastic waste management, improving efficiency in sorting and collecting recyclable materials. While both use advanced technology, Mohan utilizes the Arduino platform, whereas Daegi employs a three-step optimization process. Both contribute to technological innovation and environmental sustainability, but they address different aspects of vending machine design.

Both Ratnasria (2024) and Thete (2024) discuss the evolution of vending machines, focusing on IoT technology. Ratnasria and Sharmilan highlight advancements like cashless payments and real-time data monitoring. Thete

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

emphasizes remote inventory monitoring, real-time data analysis, and enhanced security. Both studies underscore the importance of IoT and machine learning in improving efficiency and user experience, ultimately revolutionizing the vending machine industry.

Both Huma (2022) and Deena (2020) address plastic bottle waste through reverse vending machines (RVMs). Huma emphasizes the environmental impact and challenges with current RVM solutions, while Deena proposes an RVM that uses image processing to identify plastic bottles and offers rewards to encourage recycling. Both studies aim to improve plastic waste management and promote recycling efforts.

Both Kumar (2020) and Richest (2024) address the issue of waste management with innovative solutions. Kumar focuses on recycling plastic bottles by crushing, melting, and molding them into useful products, highlighting the significant volume of plastic waste generated. Richest discusses broader waste management challenges due to urbanization, proposing solutions like waste-to-energy technologies, material recovery facilities, and composting initiatives. These approaches aim to reduce landfill waste, create job opportunities, and promote sustainable practices, positioning the Philippines as a leader in the recycling revolution.

Both Haulla (2022) and Noor (2021) address the importance of managing plastic waste but from different perspectives. Haulla discusses smart waste management technologies, such as AI-powered waste bins that identify, sort, and compress waste, reducing environmental impact and optimizing collection routes. Noor emphasizes the need to recycle non-biodegradable plastic bottles, detailing the process of collecting, sorting, crushing, and molding them for reuse. While Haulla focuses on innovative technologies to minimize waste, Noor provides a practical approach to recycling plastic bottles effectively. Both studies underscore

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

the need for efficient waste management to conserve resources and reduce greenhouse gas emissions.

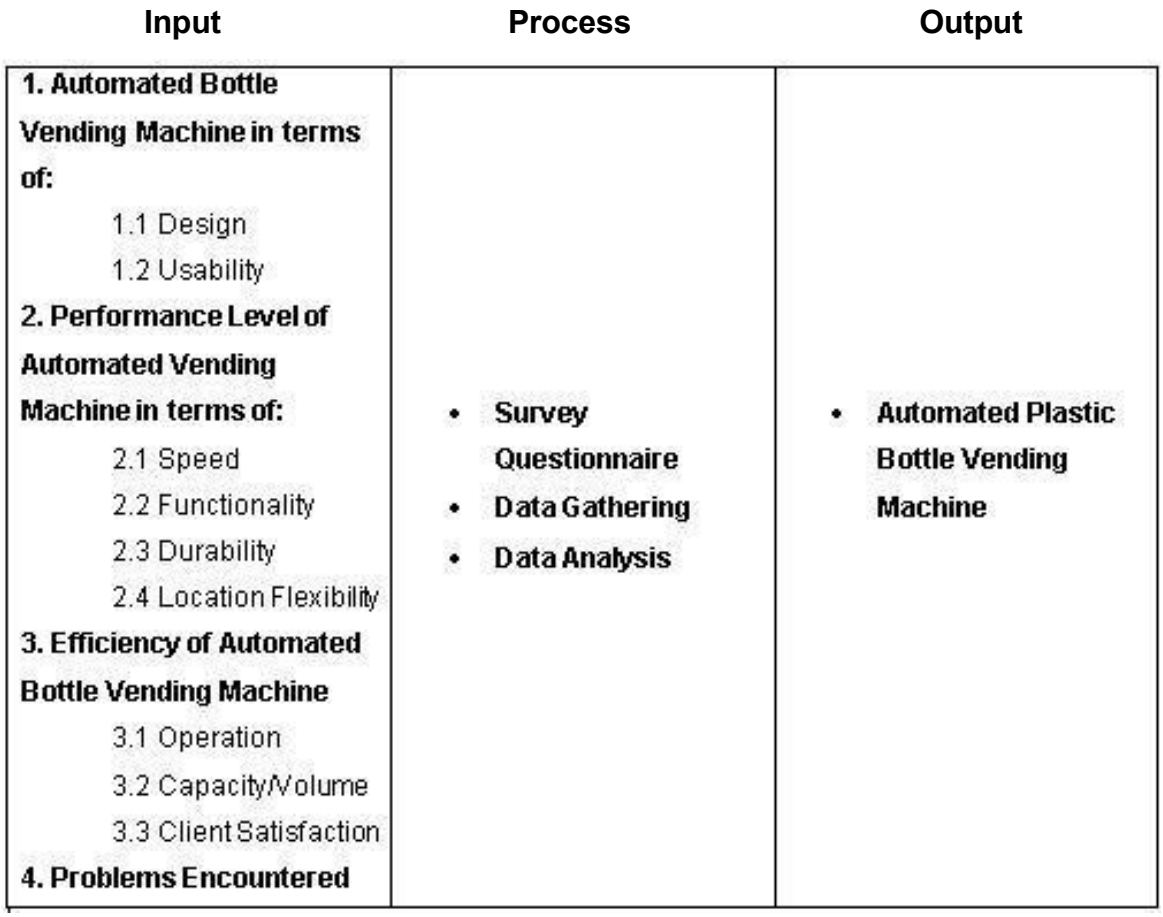


Figure 1

Conceptual Framework

Definition of Terms

To facilitate the readers' understanding of this study, the following important terms are herein defined conceptually and operationally.

Automated. This refers to the use of technology to perform tasks automatically, minimizing human intervention and increasing efficiency (Kumar et

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

al., 2019). In the context of the study, automated technology enables the vending machine to dispense plastic bottles containing pens without manual assistance.

Bottle. A rigid container typically made of plastic, glass, or metal, used for storing liquids or solids (Britannica, 2020). In this study, a plastic bottle serves as the packaging for a pen, demonstrating innovative reuse through an automated vending machine.

Capacity/Volume. The maximum amount that something can contain or produce (ISO, 2021). This study considers the capacity or volume of the vending machine in terms of how many plastic bottles containing pens it can store and dispense.

Client Satisfaction. This refers to the degree to which clients are happy with a product or service (Smith, 2019). This study measures client satisfaction by assessing users' experiences and feedback regarding the automated vending machine's performance and convenience.

Design. This refers to the process of envisioning and planning the creation of objects, systems, or processes, with attention to aesthetics, functionality, and user experience (Norman, 2019). In this study, design pertains to the layout and appearance of the automated vending machine, ensuring it is visually appealing and user-friendly.

Durability. It denotes the capacity of a material or product to withstand wear, tear, and degradation over time (ASTM International, 2020). The durability of the plastic bottle and pen is crucial in this study, ensuring they remain functional during vending and subsequent use.

Functionality. This refers to the ability of a product or system to perform its intended purpose effectively (ISO, 2020). The study examines the functionality of an automated vending machine in dispensing plastic bottles containing pens, highlighting its efficiency and convenience.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Location Flexibility. This refers to the ability to place and operate a system or machine in various locations (Kaufman, 2019). This study evaluates how easily the automated vending machine can be installed and function in different settings, increasing its accessibility and usefulness.

Operation. It is the act of running or controlling a machine, process, or system (Merriam-Webster, 2022). This study looks into the operation of the automated vending machine, focusing on the simplicity and reliability of its functioning.

Pen. This refers to a writing instrument consisting of a nib or ballpoint that dispenses ink onto a surface (Oxford Dictionary, 2020). This study utilizes pens as the primary product dispensed in plastic bottles through an automated vending machine.

Plastic. It refers to a synthetic or semi-synthetic organic solid, often molded or shaped for various uses (Merriam-Webster, 2022). In this research, plastic bottles are repurposed to hold pens, showcasing creative waste reduction through automated vending.

Speed. This refers to the rate at which a process or activity is completed (Oxford Dictionary, 2020). This study examines the speed of the vending machine in dispensing plastic bottles containing pens, highlighting its efficiency in serving users quickly.

Usability. It denotes the ease of use and learnability of a product or system (Nielsen, 2019). The study assesses the usability of the automated vending machine, focusing on how effortlessly users can interact with it to obtain their pens.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

CHAPTER III

RESEARCH METHODOLOGY

This chapter presents the methodology and procedures used in the conduct of the study. This covers the research design, subjects of the study, data gathering instruments used, data gathering procedures undertaken to complete the research, and statistical treatment employed to help in the interpretation of the data collected.

Research Design

This research study employs the quantitative research method in descriptive research design to gather data from the students of Information and Communication Technology, particularly Grade 12 Amber. The descriptive research design can be a great help in getting significant information that could act as a big help in the study. The researchers used this design because it is the most applicable research design to get, analyze, and interpret ideas.

PubGenius (2024), stated that a quantitative descriptive research design is a method used in research to investigate cause-and-effect relationships by manipulating an independent variable and measuring its effect on a dependent variable. This design involves conducting descriptive to test specific theories or hypotheses related to a particular topic. The research process typically includes clarifying the problem, reviewing relevant literature, defining the research problem, stating the purpose, formulating research questions and/or hypotheses, organizing and conducting the study, collecting and analyzing data, presenting the results, and drawing conclusions based on the findings . In quantitative research, large samples are often used, and well-designed studies can provide generalizable findings to larger populations. Randomized controlled trials are considered the gold standard design for testing treatment effectiveness in experimental research .

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Based on the citation of Zubair (2023), descriptive research is a scientific method of conducting research in which one or more independent variables are altered and applied to one or more dependent variables in order to determine their influence on the latter. It is an attempt by the researcher to maintain control over all factors that may affect the result. In doing this, the researcher attempts to determine or predict what may occur. In relation to this research study, the chosen research design can be a tool to gain all the necessary data to achieve the goals and objectives of the study. Lastly, the information that will be gathered could then be used to develop targeted interventions and alterations for the betterment of Bottle for a Pen: Via Automated Plastic Bottle Vending Machine.

Respondents of the Study

The respondents in this study were the Ģrade 12 Amber students from Information and Communication Technology (ICT) strand of Anselmo A. Sandoval Memorial National High School school year of 2024-2025. The total respondents was 35 students of Amber since they were the target section of the researchers that would test using the Bottle for a Pen: Via Automated Plastic Bottle Vending Machine. The researcher used the purposive sampling method since the respondents were selected on this purpose, as they had the characteristics that were needed in the study.

Research Instrument

This study used questionnaire that were used to survey the ICT students in Amber about the Bottle for a Pen: Via Automated Plastic Bottle Vending Machine, an automated bottle for a pen for the students. The questionnaire was developed based on the study's objectives. The questionnaire consisted of forty (40) items. And it's divided by three parts in terms of description, level of performance, and efficiency. The three parts of the questionnaire consisted of 5 questions each. The respondents answered these questions using the following

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

4 points likert scale: For Part I - the values of the scale are Strongly Agree for 4 and 1 as Strongly Disagree and for Part 2 and 3, 4 as Very Highly Manifested and 1 as Not Manifested.

The scale above was used to determine the rate of the degree of agreement of the respondents with the implementation of the Bottle For a Pen: Via Automated Plastic Bottle Vending Machine among Grade 12 students of Amber.

Construction of the Questionnaire. To determine the effectiveness and impact of Bottle for a Pen: Via Automated Plastic Bottle Vending Machine, the researchers used the questionnaire as a major instrument to gather the needed data. The researchers reviewed relevant information from online website, and thesis. The basic data and information were acquired by going to research to gain information and ideas that may be incorporated in the questionnaire. Furthermore, the questionnaire is divided into three sections: the first part contains the assessment of bottle for a pen via automated plastic bottle vending machine. Particularly, in terms of description of the automated plastic bottle vending machine the second part focuses on the level of performance and the third part are the efficiency of the bottle for a pen via automated plastic bottle vending machine. The respondents were asked to supply the needed data and put a check in their assessment.

Validation of the Questionnaire. To establish content validity, the first draft of the research-made questionnaire was presented, examined and evaluated by the thesis adviser. After all suggestions and corrections were integrated, the final draft of the questionnaire was reproduced.

Administration of the Questionnaire. The validated questionnaire was first reproduced in consonance to the number of respondents. Then, the researcher personally sought the assistance of the very accommodating adviser

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

and their respective thesis teacher. The respondents were properly guided in accomplishing the questionnaire with the aid of the designated researchers to demo in every respondent. The researchers then tallied each of the responses and this was subjected for statistical measurement.

Retrieval of Questionnaire. The questionnaires were retrieved successfully from our section. Likewise, the researcher sought the assistance of the class president through our room to obtain the 100% retrieval.

Scoring of Responses. The researchers collected information and responses from the respondents, and the population or respondents were selected on the basis of their characteristics and relationship to the study's purpose. For Part I - the values of the scale are Strongly Agree for 4 and 1 as Strongly Disagree and for Part 2 and 3, 4 as Very Highly Manifested and 1 as Not Manifested.

4-Point Scale on the Level of Agreement

Value	Scale/Range	Verbal Interpretation
4	3.25-4.00	Strongly Agree (SA)/Very Highly Manifested (VHM)
3	2.50-3.24	Agree(A)/Highly Manifested (HM)
2	1.75-2.49	Disagree(D)/Moderately Manifested (MM)
1	1.00-1.74	Strongly Disagree(SD)/Not Manifested (NM)

Data Gathering Procedures

The researchers sought permission for approval from the thesis adviser, master teacher of Anselmo A. Sandoval Memorial National High School. Upon the approval, the researchers immediately administered the questionnaires. Questionnaires were retrieved from the 35 students of Grade 12 Amber.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Yet, prior to these, the researchers presented the questionnaire to their thesis adviser for intent examination, suggestions, and validations.

For the respondents, the total 35 students of Grade 12 Amber served as the respondents of the study. Along with, the questionnaires were collected in exact numbers and subjected for statistical treatment, tabulation, analysis, and interpretation.

Statistical Analysis

The following statistical tools were used in interpreting the data gathered from the respondents:

Frequency Count. This was used to measure the frequency of usage and effectiveness of the tool.

Weighted mean. This was used to determine the extent of qualities and evaluate their access in card releasing.

$$WM = \frac{\Sigma FW}{N}$$

Where:

WM = Weighted mean
Σ = Summation symbol
F = Frequency for each option
W = Assigned weight
N = Total number of frequencies

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

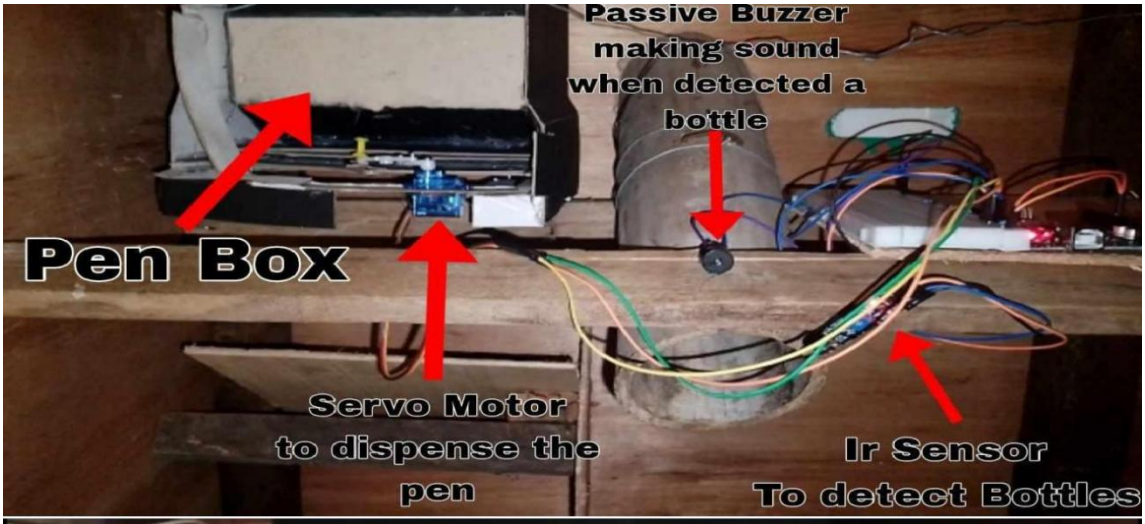
CHAPTER IV
PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

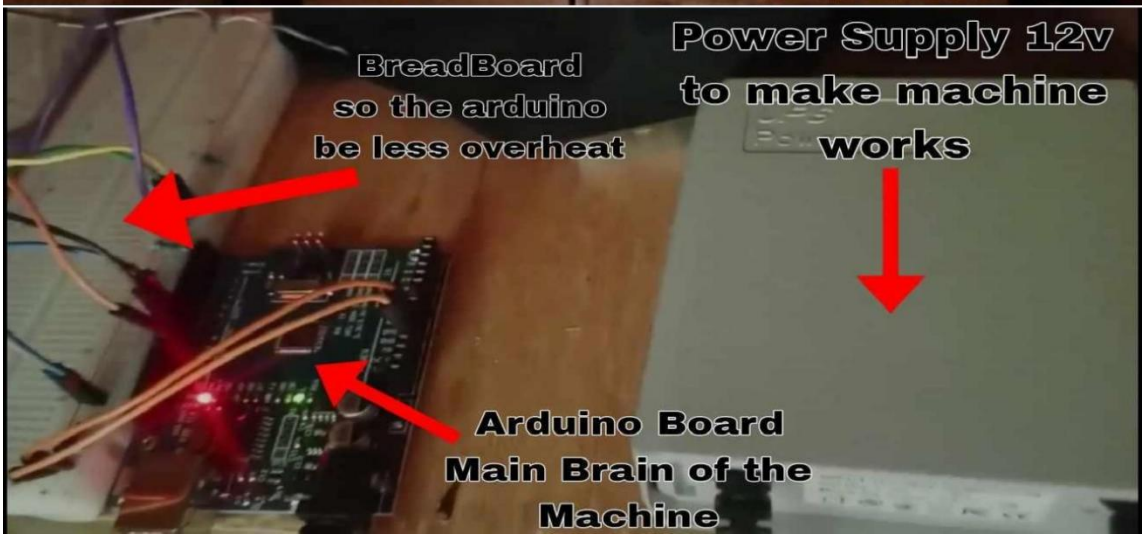
This chapter shows the presentation, analysis, and interpretation of data based on the questionnaire administered to the respondents. Such a presentation is in accordance with the specific questions posted in the statement of the problem.

1. Description of the design of Automated Plastic Bottle Vending Machine

1.1 design

Internal View





Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

External View

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

The Photos above shows the design of Bottle for a Pen: Via Automated Plastic Bottle Vending Machine. The Bottle for a Pen: Via Automated Plastic Bottle Vending Machine might provide students with an interactive interface and rewards for recycling activities. This encourages participation and encourages more people to reduce waste (Kamsiah, 2023). Through the machine, teachers and students can use the machine to reduce the waste in our school.

Table 1.2: Description Of Automated Plastic Bottle Vending Machine in terms of Usability

	Items	Weighted Mean	Verbal Interpretation
1.	The instructions for using the automated bottle vending machine are clear and easy to follow.	3.66	SA
2.	The vending machine is easy to operate without assistance.	3.34	SA
3.	The interface of the vending machine is intuitive and user-friendly.	3.60	SA
4.	The vending machine provides quick and efficient service.	3.49	SA
5.	Users are satisfied with their overall experience when using the vending machine.	3.60	SA
	COMPOSITE MEAN	3.54	SA

Legend: SA - Strongly Agree A -Agree
D - Disagree SD - Strongly Disagree

Table 1.2 presents how may automated bottle vending machine be described in terms of usability.

As presented in the Table 1.2, the usability of the automated plastic bottle vending machine is highly manifested, with a composite mean score of 3.54. The instructions for using the machine are clear and easy to follow, achieving a

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

weighted mean of 3.66. The machine is relatively easy to operate without assistance (3.34), and its interface is intuitive and user-friendly (3.60). The vending machine provides quick and efficient service (3.49), and users are generally satisfied with their overall experience (3.60). Overall, the high composite mean score reflects positive user reception and high usability of the vending machine.

2. The level performance of automated vending machine in terms of:

Table 2.1: Level of Performance of Automated Bottle Vending Machine in terms of Speed

	Items	Weighted Mean	Verbal Interpretation
1.	The transactions processes quickly.	3.34	VHM
2.	The pen dispenses immediately after bottles input..	3.34	VHM
3.	It responds well even during peak usage.	3.17	HM
4.	The transaction time is consistent regardless of user traffic.	3.29	VHM
5.	The machine processes inputs without delays or system lags.	3.34	VHM
	COMPOSITE MEAN	3.30	VHM

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NAAM - Not At All Manifested

Table 2.1 presents the level performance of automated vending machine in terms of speed.

As presented in Table 2.1, the performance of the automated bottle vending machine in terms of speed is highly manifested, with a composite mean score of 3.30. The transactions process quickly, achieving a weighted mean of

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

3.34. The pen dispenses immediately after bottles are input, also with a weighted mean of 3.34. The machine responds well even during peak usage, achieving a weighted mean of 3.17. The transaction time remains consistent regardless of user traffic, with a weighted mean of 3.29. Additionally, the machine processes inputs without delays or system lags, achieving a weighted mean of 3.34. Overall, the high composite mean score reflects positive user reception and high speed performance of the vending machine.

Table 2.2: Level of Performance of Automated Bottle Vending Machine in terms of Functionality

	Items	Weighted Mean	Verbal Interpretation
1.	The machine accepts bottles of different shapes and sizes.	3.00	HM
2.	The pen dispenses immediately after bottles input..	3.63	VHM
3.	It responds well even during peak usage.	3.31	VHM
4.	The transaction time is consistent regardless of user traffic.	3.26	VHM
5.	The machine processes inputs without delays or system lags.	3.34	VHM
	COMPOSITE MEAN	3.31	VHM

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NM - Not Manifested

Table 2.2 presents the level performance of automated vending machine in terms of functionality.

As presented in Table 2.2, the performance of the Automated Bottle Vending Machine in terms of functionality is very highly manifested, with a

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

composite mean score of 3.31. Notably, "The pen dispenses immediately after bottles are input" achieved the highest weighted mean of 3.63. The machine's response during peak usage and its processing speed also scored highly. The ability to accept bottles of different shapes and sizes, with a weighted mean of 3.00, suggests room for improvement in this area. Overall, the high composite mean score reflects positive user reception and strong functionality of the vending machine.

Table 2.3: Level of Performance of Automated Bottle Vending Machine in terms of Durability

	Items	Weighted Mean	Verbal Interpretation
1.	The machine can withstand frequent use without malfunctioning.	3.26	VHM
2.	The materials used ensure long-lasting performance.	3.43	VHM
3.	The machine operates smoothly even under environmental challenges.	3.34	VHM
4.	The machine has a user-friendly mechanism for troubleshooting minor issues.	3.60	VHM
5.	The external structure of the machine is resistant to rust and corrosion.	3.54	VHM
	COMPOSITE MEAN	3.43	VHM

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NM - Not Manifested

Table 2.3 presents the level performance of automated vending machine in terms of durability.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

As presented in Table 2.3, the performance of the Automated Bottle Vending Machine in terms of durability is very highly manifested, with a composite mean score of 3.43. Notably, "The machine has a user-friendly mechanism for troubleshooting minor issues" achieved the highest weighted mean of 3.60. The external structure's resistance to rust and corrosion also scored highly, with a weighted mean of 3.54. The machine's materials ensure long-lasting performance, achieving a weighted mean of 3.43. It operates smoothly even under environmental challenges, with a weighted mean of 3.34. The machine can withstand frequent use without malfunctioning, scoring 3.26. Overall, the high composite mean score reflects positive user reception and strong durability of the vending machine.

Table 2.4 presents the level performance of automated vending machine in terms of location flexibility.

Table 2.4: Level of Performance of Automated Bottle Vending Machine in terms of Location Flexibility

	Items	Weighted Mean	Verbal Interpretation
1.	The machine is easy to relocate if necessary.	3.57	VHM
2.	The machine's placement is suitable for user accessibility.	3.60	VHM
3.	The vending machine operates efficiently regardless of its environment.	3.51	VHM
4.	The machine is compatible with both indoor and outdoor settings.	3.66	VHM
5.	The machine's mobility allows for strategic placement to maximize usage.	3.49	VHM
	COMPOSITE MEAN	3.57	VHM

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NM - Not Manifested

As presented in Table 2.4, the performance of the Automated Bottle Vending Machine in terms of location flexibility is very highly manifested, with a composite mean score of 3.57. Notably, "The machine is compatible with both indoor and outdoor settings" achieved the highest weighted mean of 3.66. The machine's placement being suitable for user accessibility also scored highly, with a weighted mean of 3.60. The machine is easy to relocate if necessary, achieving a weighted mean of 3.57. It operates efficiently regardless of its environment, with a weighted mean of 3.51. The machine's mobility allowing for strategic placement to maximize usage scored 3.49. Overall, the high composite mean score reflects positive user reception and strong location flexibility of the vending machine.

3. Efficiency of the Automated Plastic Bottle Vending Machine in terms of:

Table 3.1 presents the efficiency of the automated plastic bottle vending machine in terms of operation.

As presented in Table 3.1, the efficiency of the Automated Bottle Vending Machine in terms of operation is very highly manifested, with a composite mean score of 3.47. Notably, "The posted procedures of exchanging bottles for pens are clear and easy to understand" achieved the highest weighted mean of 3.74. The machine exchanges plastic bottles for pens smoothly, achieving a weighted mean of 3.63. It processes each exchange efficiently and timely, with a weighted mean of 3.49. The machine maintains consistent performance under heavy usage, scoring 3.37. However, the reliability in completing transactions without errors scored 3.11, suggesting room for improvement in this area. Overall, the high composite mean score reflects positive user reception and high efficiency in the operation of the vending machine.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Table 3.1: Efficiency of Automated Bottle Vending Machine in terms of Operation

	Items	Weighted Mean	Verbal Interpretation
1.	The Bottle for a Pen automated vending machine exchanges plastic bottles for pens smoothly.	3.63	VHM
2.	The vending machine is reliable in completing transactions without errors.	3.11	HM
3.	The vending machine processes each exchange efficiently and timely.	3.49	VHM
4.	The vending machine maintains consistent performance under heavy usage.	3.37	VHM
5.	The posted procedures of exchanging bottles for pens are clear and easy to understand.	3.74	VHM
	COMPOSITE MEAN	3.47	VHM

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NM - Not Manifested

Table 3.2 presents the efficiency of the automated plastic bottle vending machine in terms of capacity/volume.

As presented in Table 3.2, the efficiency of the Automated Bottle Vending Machine in terms of capacity and volume is very highly manifested, with a composite mean score of 3.50. Notably, "The vending machine's frequency of getting to be emptied or pen refilled is manageable" and "The vending machine's holding capacity plays overall good performance" both achieved a high weighted mean of 3.54. The machine's capacity for holding plastic bottles scored a weighted mean of 3.51, indicating it is adequate. The machine efficiently

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

manages the storage of pens for dispensing, with a weighted mean of 3.46. It handles high volumes of usage efficiently, scoring 3.43. Overall, the high composite mean score reflects positive user reception and high efficiency in the capacity and volume of the vending machine.

Table 3.3 presents the efficiency of the automated plastic bottle vending machine in terms of client satisfaction.

Table 3.2: Efficiency of Automated Bottle Vending Machine in terms of Capacity/Volume

	Items	Weighted Mean	Verbal Interpretation
1.	The vending machine's capacity for holding plastic bottles is adequate.	3.51	VHM
2.	The vending machine's frequency of getting to be emptied or pen refilled is manageable.	3.54	VHM
3.	The vending machine handles high volumes of usage efficiently.	3.43	VHM
4.	The vending machine efficiently manages the storage of pens for dispensing.	3.46	VHM
5.	The vending machine's holding capacity plays overall good performance.	3.54	VHM
	COMPOSITE MEAN	3.50	VHM

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NM - Not Manifested

As presented in Table 3.3, the efficiency of the Automated Bottle Vending Machine in terms of client satisfaction is very highly manifested, with a composite mean score of 3.77. Notably, "Clients are satisfied with the overall experience of

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

using the vending machine" achieved the highest weighted mean of 3.77. The machine meets clients' expectations for exchanging bottles for pens, achieving a weighted mean of 3.71. Clients are satisfied with the availability and functionality of the vending machine, with a weighted mean of 3.69. The likelihood of clients recommending the vending machine to others and the belief that it effectively promotes sustainability both scored a weighted mean of 3.60. Overall, the high composite mean score reflects positive user reception and high efficiency in client satisfaction with the vending machine.

Table 3.3: Efficiency of Automated Bottle Vending Machine in terms of Client Satisfaction

	Items	Weighted Mean	Verbal Interpretation
1.	Clients are satisfied with the overall experience of using the vending machine.	3.77	VHM
2.	Clients are likely to recommend the vending machine to others.	3.60	VHM
3.	The vending machine meets clients' expectations for exchanging bottles for pens.	3.71	VHM
4.	Clients are satisfied with the availability and functionality of the vending machine.	3.69	VHM
5.	Clients believe the vending machine effectively promotes sustainability.	3.60	VHM
	COMPOSITE MEAN	3.77	VHM

Legend: VHM - Very Highly Manifested HM - Highly Manifested
MM - Moderately Manifested NM - Not Manifested

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary of findings, conclusions, and recommendations of the study.

Summary

This study aimed to design and evaluate the Bottle for a Pen: An Automated Plastic Bottle Vending Machine among Anselmo A. Sandoval Memorial National High School S.Y 2024-2025.

Specifically, this study sought to answer the following questions:

1. How may automated bottle vending machine be described in terms of:
   1.1 design, and
   1.2 usability?
2. What is the level performance of automated vending machine in terms of:
   2.1 speed;
   2.2 functionality;
   2.3 durability; and
   2.4 location flexibility?
3. How efficient is the automated bottle vending machine in terms of:
   3.1 operation;
   3.2 capacity/volume, and
   3.3 client satisfaction?
4. What are the problems encountered in the utilization of automated bottle vending machine?
5. Based on the findings, what action may be proposed to enhance the automated plastic bottle vending machine?

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

This research study employs the quantitative research method in an descriptive research design to gather data from the 35 students of Information and Communication Technology, particularly Grade 12 Amber in Anselmo A. Sandoval Memorial National High School.

Responses were interpreted using the weighted mean.

Findings

1. The automated plastic bottle vending machine, Bottle for a Pen, was well-received in terms of its design, usability, speed, functionality, durability, and location flexibility. The composite mean score for usability was 3.54, with the highest weighted mean being 3.66 for clear instructions, and the lowest weighted mean being 3.34 for accessibility.
2. The machine is efficient in terms of speed, with quick transactions and immediate pen dispensing. The composite mean score for speed was 3.30, with the highest weighted mean being 3.34 for quick transactions and pen dispensing, and the lowest weighted mean being 3.29 for consistency of transaction time.
3. The machine performs well, reliably dispensing pens and functioning efficiently during peak usage. The composite mean score for functionality was 3.31, with the highest weighted mean being 3.63 for dispensing pens, and the lowest weighted mean being 3.00 for accepting different bottle shapes.
4. The machine is durable with long-lasting materials and smooth operation. The composite mean score for durability was 3.43, with the highest weighted mean being 3.60 for user-friendly troubleshooting, and the lowest weighted mean being 3.26 for withstanding frequent use without malfunctioning.
5. Students are highly satisfied with the machine and are likely to recommend it. The composite mean score for client satisfaction was 3.77, with the highest

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

weighted mean being 3.77 for the overall experience, and the lowest weighted mean being 3.60 for recommending the machine and promoting sustainability.

Conclusions

The following conclusions were drawn in light of the study's significant findings:

1. The automated plastic bottle vending machine is exceptionally usable.
2. The performance level of the bottle vending machine is excellent.
3. The efficiency level of the bottle vending machine is excellent.
4. Modification may be done on functionality and speed.

Recommendations

Considering the significant findings revealed and conclusions drawn in the study, the following recommendations are offered:

1. Further improvement of the vending machine with interactive features and educational content to engage students and promote sustainability.
2. Expand the machine's use to other schools to increase its impact on reducing plastic waste.
3. Research the long-term effects on students' recycling habits and overall waste reduction.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

BIBLIOGRAPHY

A. Journals

Baribad, J. (2024). Overcome the problem of waste: Reverse vending machine for plastic bottles. International Journal of Research Publication and Reviews, 2(8), 24-29. https://www.ijrpr.com/uploads/V2ISSUE8/IJRPR904.pdf.

Gaur, A., Mathuria, D., & Priyadarshini, R. (2018). A simple approach to design reverse vending machine. International Journal of Electronics, Electrical, and Computational System, 7(3). ISSN 2348-117X. https://www.researchgate.net/publication/326533902_A_Simple_Approach_to_Design_Reverse_Vending_Machine

Kokulin, A. N., Tur, A. I., & Yuzhakov, A. A. (2018). Convolution neural networks application in plastic waste recognition and sorting. 2018 IEEE Conference of Russian Young Researchers in Electrical and Electronics Engineering (EIConRus), 127-134. https://www.researchgate.net/publication/323864747_Convolutional_neural_networks_application_in_plastic_waste_recognition_and_sorting

Mohamed, E., Pauzi, M. N. M., & Ridzuan, M. H. (2023). A prototype of smart plastic bottle recycle machine using IoT. International Journal of Advanced Trends in Computer Science and Engineering, 12(6), 1-10. https://www.warse.org/IJATCSE/static/pdf/file/ijatcse011262023.pdf.

B. Online Sources

Dacay, J., Sapida, D., Jumawan, I. Z., Dela Cruz, M. K., & Paran, S. J. (2024). VENDOBIN: An IoT-based plastic bottle waste disposal vending machine. ResearchGate. https://www.researchgate.net/publication/369659930_VENDOBIN_An_IOT-based_Plastic_Bottle_Waste_Disposal_Vending_Machine.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Haulla. (2022). 9 innovative waste management technologies today. *Haulla Blog*. https://www.haulla.com/blog/9-innovative-waste-management technologies

Richest Philippines. (2024). Innovative waste solutions in the Philippines. *Richest Philippines*. https://richestph.com/innovative-waste-solutions-in-the-philippines/

Wikipedia contributors. (n.d.). Reverse vending machine. Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Reverse_vending_machine.

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

APPENDICES

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

APPENDIX A

LETTER TO THE RESPONDENTS

Dear Respondents,

Greetings of blessing and peace!

We are the researchers from ICT of Anselmo A. Sandoval Memorial National High School who are currently conducting a study entitled **"Bottle for a Pen: Via Automated Plastic Bottle Vending Machine"** as partial fulfillment of the requirements for the subject Inquiries, Investigations, and Immersion. This study aims to assess the effectiveness of the automated plastic bottle vending machine in promoting recycling habits and environmental awareness among students.

In line with this, we humbly request your time, understanding, and cooperation to answer honestly all the questions listed in our questionnaire. Your responses will provide valuable insights into how well the vending machine encourages proper disposal of plastic bottles and its overall impact on the school's sustainability initiatives. Rest assured that all the information gathered will be used for research purposes only and will be kept confidential.

We are looking forward to your positive response and full participation.

Thank you very much!

Respectfully yours,

JHERWIN S. JASO
JOHN JOREN V. SOMBILON
MARIA ROSALYN S. DOLOR
RICA JHANE J. GUNIO
CHRISTINE JOY M. MATIRA
AILEEN V. PRESTO
MIKEL JAZLE D. SARMIENTO
ANDREW JEOYAM M. GONDA
ANDIE LUC C. MAALA
PAUL FRANCIS D. MANONGSONG
RALPH JAREEZ D. RAMOS
JOHN JUSTIN B. REYES

Noted:

Dr. Marilou A. Escalona
Research Adviser

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

APPENDIX B
QUESTIONNAIRE

Dear Respondent,

This study aims to evaluate gather feedback on the Bottle for a Pen: Via Automated Plastic Bottle Vending Machine at Anselmo A. Sandoval Memorial National High School for the S.Y 2024-2025. Your responses will provide valuable insights into the design, performance, effectiveness, challenges, and areas for improvement of the machine.

Rest assured that your responses will be kept in utmost confidentiality. Likewise, the researchers are hoping for your cooperation and honest response.

Thank you and God bless.
Very truly yours,
Group II Researchers
G12 Amber

Directions:

Kindly answer all items honestly based on likert scale below.

Scale:

4 - Strongly Agree
3 - Agree
2 - Disagree
1 - Strongly Disagree

Part I: Description of automated plastic bottle vending machine in terms of:

Usability	4	3	2	1
1. The instructions for using the automated bottle vending machine are clear and easy to follow.				
2. The vending machine is easy to operate without assistance.				
3. The interface of the vending machine is intuitive and user-friendly.				
4. The vending machine provides quick and efficient service.				
5. Users are satisfied with their overall experience when using the vending machine.				

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

Directions:

Kindly answer all items honestly based on likert scale below.

Scale:

4 - Very Highly Manifested
3 - Highly Manifested
2 - Moderately Manifested
1 - Not At All Manifested

Part II:Level of Performance in terms of:

2.1 Speed	**4**	**3**	**2**	**1**
1. The transactions processes quickly.				
2. The pen dispenses immediately after bottles input.				
3. It responds well even during peak usage.				
4. The transaction time is consistent regardless of user traffic.				
5. The machine processes inputs without delays or system lags.				
2.2 Functionality	**4**	**3**	**2**	**1**
1. The machine accepts bottles of different shapes and sizes.				
2. The machine reliably dispenses the correct number of pens per transaction.				
3. The system prevents errors such as double-dispensing or rejecting valid bottles.				
4. The machine's components are resistant to wear and tear.				
5. The machine remains functional even after prolonged operation.				
2.3 Durability	**4**	**3**	**2**	**1**
1. The machine can withstand frequent use without malfunctioning.				

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

2. The materials used ensure long-lasting performance.				
3. The machine operates smoothly even under environmental challenges.				
4. The machine has a user-friendly mechanism for troubleshooting minor issues.				
5. The external structure of the machine is resistant to rust and corrosion.				
2.4 Location Flexibility	**4**	**3**	**2**	**1**
1. The machine is easy to relocate if necessary.				
2. The machine's placement is suitable for user accessibility.				
3. The vending machine operates efficiently regardless of its environment.				
4. The machine is compatible with both indoor and outdoor settings.				
5. The machine's mobility allows for strategic placement to maximize usage.				

Part III: Efficiency of the Automated Plastic Bottle Vending Machine in terms of:

Directions:

Kindly answer all items honestly based on likert scale below.

Scale:

4 - Very Highly Manifested
3 - Highly Manifested
2 - Moderately Manifested
1 - Not At All Manifested

3.1 Operation	**4**	**3**	**2**	**1**
1. The Bottle for a Pen automated vending machine exchanges plastic bottles for pens smoothly.				

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

2.	The vending machine is reliable in completing transactions without errors.				
3.	The vending machine processes each exchange efficiently and timely.				
4.	The vending machine maintains consistent performance under heavy usage.				
5.	The posted procedures of exchanging bottles for pens are clear and easy to understand.				
	3.2 Capacity/Volume	**4**	**3**	**2**	**1**
1.	The vending machine's capacity for holding plastic bottles is adequate.				
2.	The vending machine's frequency of getting to be emptied or pen refilled is manageable.				
3.	The vending machine handles high volumes of usage efficiently.				
4.	The vending machine efficiently manages the storage of pens for dispensing.				
5.	The vending machine's holding capacity plays overall good performance.				
	3.3 Client Satisfaction	**4**	**3**	**2**	**1**
1.	Clients are satisfied with the overall experience of using the vending machine.				
2.	Clients are likely to recommend the vending machine to others.				
3.	The vending machine meets clients' expectations for exchanging bottles for pens.				
4.	Clients are satisfied with the availability and functionality of the vending machine.				
5.	Clients believe the vending machine effectively promotes sustainability.				

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

CURRICULUM VITAE

I. PERSONAL INFORMATION

Name: Jherwin S. Jaso

Address: Anilao East, Mabini, Batangas

Birthday: March 26, 2007

Age: 17

Email Address: jherwinjaso26@gmail.com

Contact No.: 09153262471

Father's Name: Darwin V. Jaso

Mother's Name: Jennifer Sto. Tomas Jaso

II. EDUCATIONAL ATTAINMENT

Elementary Level: Mabini, Central, School
P. Niogan, Mabini, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Andie Luc C. Maala

Address: Nag-iba, Mabini Batangas

Birthday: October 17, 2006

Age: 18

Email Address: maalaandie03@gmail.com

Contact No.: 09120306807

Father's Name: Edgardo D. Maala

Mother's Name: Dominga C. Maala

II. EDUCATIONAL ATTAINMENT

Elementary Level: Nag-iba, Elementary School
Nag-iba, Mabini Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Mikel Jazle De. Sarmiento

Address: Gasang Centro Mabini Batangas

Birthday: July 10, 2006

Age: 18

Email Address: mikeljazlesarmiento@gmail.com

Contact No.: 09455319725

Father's Name: Michael V. Sarmiento

Mother's Name: Edlili Jane De. Sarmiento

II. EDUCATIONAL ATTAINMENT

Elementary Level: Gasang Elementary School
Gasang, Mabini Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Aileen V. Presto

Address: Centro Sampaguita, Mabini, Batangas

Birthday: September 17, 2005

Age: 19

Email Address: prestoaileen0@gmail.com

Contact No.: 09155035187

Father's Name: Christian G. Presto

Mother's Name: Vivian V. Presto

II. EDUCATIONAL ATTAINMENT

Elementary Level: Mabini, Central, School
P.Niogan, Mabini, Batangas
S.Y. 2014-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: John Justin B. Reyes

Address: Majuben, Mabini Batangas

Birthday: August 2, 2007

Age: 17

Email Address: justinreyes194@gmail.com

Contact No.: 09936221861

Father's Name: Rolando C. Reyes

Mother's Name: Gemma B. Reyes

II. EDUCATIONAL ATTAINMENT

Elementary Level: Anilao, Elementary,School
Anilao, Mabini, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Ma. Rosalyn S. Dolor

Address: Saguing Mabini Batangas

Birthday: September 6, 2006

Age: 18

Email Address: rosalynmaria6@gmail.com

Contact No.: 09507797670

Father's Name: Erwin M. Dolor

Mother's Name: N/A

II. EDUCATIONAL ATTAINMENT

Elementary Level: Talaga Elementary School
Talaga Proper, Mabini, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Business Administration

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Paul Francis D. Manongsongr

Address: Bulacan Mabini Batangas

Birthday: September 6, 2006

Age: 19

Email Address: dalawampufrancis01@gmail.com

Contact No.: 0969 446 3083

Father's Name: Frankco M. Manongsong

Mother's Name: Donna D. Manongsong

II. EDUCATIONAL ATTAINMENT

Elementary Level: Colvo Elementary School
Sampaguita, Bauan, Batangas
S.Y 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Santa Teresa College

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Rica Jhane J. Gunio **Address:** Calamias, Mabini Batangas **Birthday:** August 10,2007

Age: 17

Email Address: guniorica@gmail.com

Contact No.: 09535801445

Father's Name: Rodrigo D.Gunio

Mother's Name: Janice J.Gunio

II. EDUCATIONAL ATTAINMENT

Elementary Level: Mainaga Elementary , School
Mainaga, San Francisco, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: John Joren V.Sombilon

Address: Laurel Mabini Batangas

Birthday: October 20 2007

Age: 17

Email Address: sombilonjohnjoren1@gmail.com

Contact No.: 09660852918

Father's Name: Efren V. Sombilon

Mother's Name: Justa V.Sombilon

II. EDUCATIONAL ATTAINMENT

Elementary Level: Laurel Elementary School
Laurel, Mabini, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Jeoyam Andrew M. Gonda

Address: Sto.nino,Mabini, Batangas

Birthday: October 21,2007

Age: 17

Email Address: andrewgonda51@gmail.com

Contact No.: 09453380203

Father's Name: Joe M. Gonda

Mother's Name: Joan M. Gonda

II. EDUCATIONAL ATTAINMENT

Elementary Level: SanJoaquin Elementary School
Pasig City
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Ralph Jareez D. Ramos

Address: P.niogan,Mabini, Batangas

Birthday: January 11,2007

Age: 18

Email Address: rjareez11@gmail.com

Contact No.: 09632271266

Father's Name: Rafael E. Ramos

Mother's Name: Jonel D. Ramos

II. EDUCATIONAL ATTAINMENT

Elementary Level: Mabini, Central, School
P.Niogan, Mabini, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology

School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com

I. PERSONAL INFORMATION

Name: Christine Joy Matira **Address:**
San Jose Mabini Batangas **Birthday:**
December 15 2007
Age: 17
Email Address: christinejoy4275@gmail.com
Contact No.: 09208397244
Father's Name: Cesar Matira
Mother's Name: Josephine Matira

II. EDUCATIONAL ATTAINMENT

Elementary Level: San Jose Elementary School
San Jose, Mabini, Batangas
S.Y. 2013-2019

Junior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2019-2023

Senior High School Level: Anselmo A. Sandoval MNHS
Balibaguhan, Mabini, Batangas
S.Y. 2023-2025

III. COLLEGE PREFERENCE

Course: Bachelor of Science in Information and Technology
School: Batangas States University

Address: P. Balibaguhan, Mabini, Batangas
Telephone No.: (043) 487-0550
Email: aasmnhs_mabini@yahoo.com