STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY - BACOOR CITY CAMPUS

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Bachelor of Science in Information Technology

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An undergraduate capstone project proposal submitted to the faculty of the Department of Information Technology, Cavite State University, Cavite in partial fulfillment of the requirements for the degree of Bachelor of Science in Information Technology with Contribution No._____ Prepared under the supervision of Ms. Donnalyn B. Montallana, MIT.

INTRODUCTION

The rapid advancement of technology has transformed how people access products and services. Automation has become a key driver in simplifying and accelerating daily life. One of the most significant innovations in this regard is the vending machine, an automated device designed to dispense items such as snacks, beverages, and other essential goods with minimal human intervention. While vending machines are widely recognized for providing quick solutions to consumer needs, their application has expanded beyond conventional uses, now including educational tools, particularly in schools and universities. School supply vending machines address the common issue of accessibility to learning materials. Students often find themselves unprepared or urgently in need of basic supplies, such as pens and yellow paper, especially during exams or other critical academic activities. Integrating vending machines for school supplies within campus premises offers an immediate solution to these needs, enabling students to focus on their studies without unnecessary disruptions. (George C. Marshall, 2021)

Japan’s role as a pioneer in vending machine technology continues well into the 2020s. While the number of machines dropped slightly to around 4 million by the end of 2022, the density remains striking—equating to nearly one machine per 23 people—affirming their deeply rooted presence in society (Yano Research Institute, 2023)

Moreover, vending technology is innovatively repurposed for public safety: since 2023, some municipalities have deployed machines that automatically dispense food and water for free during emergencies like earthquakes and typhoons—hardly the ordinary retail function most associate with them (Mainichi and Vending Times, 2023) Japan’s vending culture also spans nostalgia and community engagement—as seen in Sagamihara’s Vending Machine Park, a retro-themed attraction that draws hundreds of visitors daily.

Inspired by these advancements, universities in the Philippines can adopt similar vending machine solutions to improve accessibility to essential goods. In particular, Cavite State University – Bacoor City Campus presents an opportunity to address students' challenges in acquiring basic school materials. Many students struggle to obtain essential supplies such as ballpoint pens, correction tape, and index cards, especially during critical academic periods like exams and project submissions. The inability to access these items promptly can result in unnecessary stress, disruptions in academic work, and wasted time searching for alternatives. By implementing a school supplies vending machine, the university can provide a convenient, cost-effective, and readily available solution, and easy learning experience.

Project Context

Students often struggle when they misplace essential school materials at home, leading to last-minute purchases that can cause unnecessary stress, long queues, and delays. This issue becomes more problematic when students urgently need items such as

ballpoint pens, correction tape, or bond paper, as the lack of a quick and convenient way to buy these supplies may result in tardiness, loss of focus, and decreased productivity in class.

To address this concern, they conducted an initial survey with 35 students to understand their purchasing behavior and willingness to buy stationery from a vending machine. The results indicated that most students frequently purchase ball pens and other stationery items, primarily from sari-sari stores and online platforms, with an average price range of ₱10 to ₱30 per unit. Quality was identified as the most important factor in their purchasing decisions, with many students expressing dissatisfaction over low product quality and unavailability. While vending machines are commonly associated with food and beverages, a significant number of students showed interest in using one for stationery due to the convenience it offers. Based on these findings, an effective vending machine solution should prioritize high-quality products, affordable pricing, frequent stock replenishment, and a simple cash payment system to ensure accessibility at all times.

Furthermore, this project aligns with the university's "Garbage In, Garbage Out" policy, which promotes proper waste management. By encouraging students to take responsibility for their waste, this initiative supports a cleaner and more organized campus environment while providing an essential and accessible solution for school supplies.

Objectives of the Study

The general objective of the study was to design, and develop a school stationery vending machine for Cavite State University - Bacoor City Campus to provide students with a convenient and efficient way to purchase essential supplies.

Specifically, it aimed to:

1. design the school stationery vending machine that would determine the optimal size and layout for various school supplies, considering factors such as product dimensions and quantity; and this aligns with the designing phase of the incremental prototyping

methodology, where the system layout is planned, and essential components are selected to ensure functionality and efficiency.

2. develop the vending machine using the following:

a. Arduino IDE 2.3.4

b. Arduino Mega

c. Coin Hopper

d. C++ 23

e. DC Buck Converter

f. DC Gear Motor Box

g. ESP32 Wi-Fi Module

h. Firebase

i. Infrared Sensor

j. Keyboard Keypad

k. L298N DC Motor Driver

l. LCD2004A with I²C interface

m. Logic Level Converter

n. Next.js

o. Universal Coinslot

p. Vending Machine Aluminum Frame

q. Vending Machine Spring

r. Visual Studio Code (VS Code)

s. 12V 7A Power Supply

t. 12V 7A Rechargeable Battery

3. test the system in terms of unit, integration, and system testing;
4. evaluate the system using the adapted ISO 25010 evaluation instrument; and
5. prepare an implementation plan.

Purpose and Description

The proposed coin-based school stationery vending machine was developed to improve accessibility to important school supplies for students, professors, and administrative personnel of Cavite State University – Bacoor City Campus. The project aims to provide a reliable and readily available source of products such as ballpens, correction tapes, and markers throughout the university. This idea intends to boost productivity, eliminate dependence on external stores, and foster a more efficient academic atmosphere. Moreover, it overcomes frequent difficulties such as limited store hours, unanticipated supply shortages, and the inconvenience of leaving the campus for modest purchases. The significance of the study is explained as follows:

Students of Cavite State University – Bacoor City Campus

The vending machine made it easy for students to get school supplies whenever they needed them, especially during class or exam time. It made it unnecessary to leave campus to get essential supplies, which saved time and effort. This technique helped students be more productive and keep their academic activities going without interruption.

Faculty and Administrative Staff

Faculty members and administrative staff benefited from the system’s availability of essential writing tools without the need to depend on nearby stores. This made their daily teaching and clerical work easier, which helped the office run more smoothly and efficiently. Also, it helped with time management and made the institution's workflow better.

Future Researchers

The study serves as a reference for future studies concentrating on automated vending systems, smart transaction processes, and sustainable campus improvements. It lays the groundwork for future upgrades, such adding digital payments, real-time inventory tracking, and more products to fulfill the requirements of a wider range of students.

Time and Place of the Study

The study was conducted at Cavite State University - Bacoor City Campus, located in Soldiers Hills IV, Molino VI, Bacoor City, Cavite, as well as at the residence of the group leader, where the majority of the system design, development, and testing activities were carried out. Regular coordination among the researchers was maintained through online meetings and group chat communications to ensure consistent progress, task monitoring, and updates throughout the entire project.

In November 2024, the researchers gathered ideas and conducted initial research at the residence of their leader. Through brainstorming and feasibility discussions, the team conceptualized the idea for the Stationery Go: School Supplies Vending Machine, aiming to automate the sale of essential school supplies within the university premises. During this month, online meetings were also conducted to finalize the project title, objectives, and scope.

In December 2024, the proposal defense was conducted at the fourth floor of the new building at Cavite State University - Bacoor Campus. The project proposal was successfully accepted, marking the official start of the study. Coordination and updates among group members were done through online discussions to refine the documentation and presentation.

In January 2025, the researchers conducted a survey at Cavite State University - Bacoor Campus to gather data regarding students’ preferences and the feasibility of installing a

vending machine dedicated to school supplies. The survey results provided valuable insights into potential product selection and pricing. During this month, the team maintained online coordination to consolidate survey data and finalize the system's functional requirements.

During February 2025, the researchers planned the list of components and materials required for the initial hardware design. The design phase took place at the leader's residence, where the team used Arduino Uno, Arduino IDE, push buttons, and servo motors to build the initial hardware prototype. Simultaneously, the software design was developed using React for the front-end and Django for the back-end. Online meetings were held to coordinate the design progress and delegate individual tasks.

From March to May 2025, the team focused on assembling all the essential components for the prototype implementation. Major functionalities such as coin acceptance**,** item dispensing, and the software's preliminary interface were tested and validated separately. Although the software was not yet integrated into the hardware, it functioned correctly as a standalone system. Throughout this phase, the researchers held regular online meetings and chat discussions to track progress, troubleshoot minor hardware issues, and ensure that each functionality aligned with the project's objectives.

In June 2025, the team conducted system testing at the leader's residence to evaluate hardware stability and feature responsiveness. The software remained under refinement and testing in simulation. The initial defense was held during this month at the fourth floor of the new building at Cavite State University - Bacoor Campus. The technical adviser, Ms. Donnalyn B. Montallana, MIT, and the technical critic, Mr. Edmund C. Martinez, reviewed the project on February 5, 2025, and June 4, 2025, respectively, ensuring that the system met academic and technical standards. Regular online meetings were conducted to prepare documentation and address pre-defense concerns.

From August to September 2025, the team implemented the revisions recommended by the panelists during the initial defense. Several hardware and software modifications were

introduced based on their feedback. The researchers upgraded from Arduino Uno to Arduino Mega for better performance and additional pin capacity, replaced push buttons with a keypad for enhanced user input control, and changed the machine's structure from plywood to an aluminum frame with a glass front panel for improved durability and presentation. Additionally, the team acquired a dedicated motor box for more efficient item dispensing and upgraded the spring coils for smoother mechanical operation. On the software side, the researchers transitioned from React and Django to Next.js and Firebase, which provided a more efficient development framework and simplified IoT integration with the ESP32 module. The hardware assembly and revisions were completed at the leader's home, while the software updates were developed at Valenzuela's residence. Consistent coordination continued through online meetings and chat communication to ensure all revisions were properly implemented and tested.

Finally, in October 2025, the final integration of both hardware and software was conducted at the leader's residence. During this stage, the vending machines IoT system and inventory management software were successfully combined and tested as one unified system. The team held final online meetings to verify the system's performance, finalize documentation, and prepare for the concluding presentation. This month marked the full completion of the Stationery Go: School Supplies Vending Machine, integrating both hardware innovation and software management into a cohesive and functional system.

Scope and Limitations

This study aimed to develop a school supplies vending machine for Cavite State University - Bacoor City Campus, providing students and faculty with a convenient way to purchase pens, correction tape, and markers. The vending machine featured an automated dispensing system, a user-friendly interface, and a coin-only payment system for simple and accessible transactions. This project focused on improving accessibility and convenience, ensuring that students could quickly obtain essential school materials without leaving the

campus. The vending machine had a storage capacity designed to cater to the needs of students and faculty, holding up to 180 items, with 15 pieces per item. This capacity ensured that the machine remained stocked for an extended period, reducing the frequency of restocking while maintaining availability for users. By providing an ample supply of essential school materials, the vending machine aimed to enhance accessibility and convenience within the campus.

Therefore, this study was limited to a coin-only payment system, restricting the vending machine from accepting digital or card transactions. Additionally, the machine relied solely on the power supply without an uninterruptible power source (UPS); however, a 12V 7A rechargeable battery backup system was integrated. In the event of a power outage, the vending machine remained operational for a few minutes, allowing ongoing transactions to be completed. However, it became temporarily non-operational once the battery charge was depleted. These limitations affected accessibility and continuous usage but were considered necessary to keep the system simple, cost-effective, and aligned with the project's scope. Furthermore, the vending machine will incorporate a universal coin mechanism capable of accepting both old and new coins to accommodate a wider range of users and ensure seamless transactions. Alongside this, a coin hopper function will be implemented to dispense coins as change when necessary, enhancing transaction accuracy and efficiency. Two-coin hoppers were utilized one designated for ₱1 coins and another for ₱5 coins to ensure accurate and flexible change dispensing. The coin hopper also aids in monitoring the total amount of coins inside the machine, simplifying maintenance and collection procedures for operators. Additionally, a failsafe system was implemented, allowing the machine to remain operational for a few minutes during a power outage to complete any ongoing transactions, ensuring that customers did not lose their money due to sudden power interruptions.

Conceptual Framework

The conceptual framework of the study used the Input-Process-Output model for STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY – BACOOR CITY CAMPUS to guide the design, development, and evaluation of the school stationery vending machine. This model provides a structured approach to understanding the project's stages.

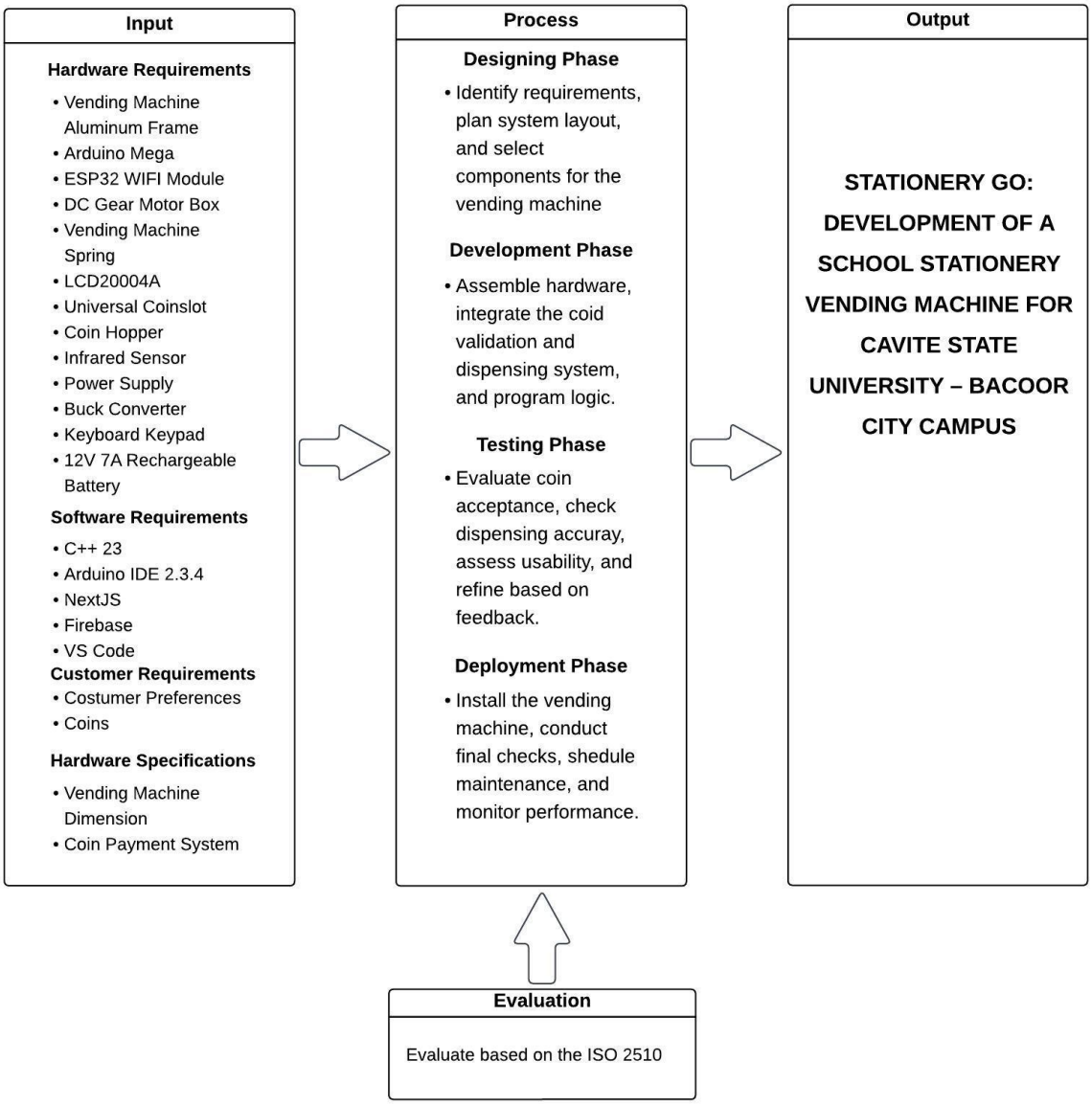


Figure 1. The conceptual framework for the Stationery Go: School Stationery

The Input Phase includes the essential components required for the vending machine's development. Hardware components include the Arduino Uno R3, LCD, servo

motor, push button, 1239A Universal Coin Slot, DC 12V 10A power supply, DC motor gear, L298N motor driver, buck converter, and an Arduino Uno R3 case. The software requirements consist of C++ 23 and Arduino IDE 2.3.4, which are used for programming and system control. Additionally, customer requirements such as coin-based transactions and user preferences are considered, along with hardware specifications that define the vending machine's dimensions, design, and payment system functionality.

This process begins with the designing phase, where requirements are identified, the layout is planned, and components are selected. In the development phase, hardware is assembled, the coin validation and dispensing system is integrated, and control logic is programmed. The testing phase checks coin acceptance, dispensing accuracy, and usability, making improvements as needed. Finally, the deployment phase involves installing the vending machine, performing final checks, and scheduling maintenance.

The Output Phase delivers STATIONERY GO, a fully functional, coin-operated stationery vending machine designed to provide students at Cavite State University - Bacoor City Campus with an automated and accessible way to purchase school supplies.

Definition of Terms

The following terms are operationally defined in the study:

Accuracy – The degree to which the output or result of a system matches the expected or correct value.

Algorithm – A set of rules or steps that a computer program follows to solve a problem or complete a task.

Arduino IDE (Integrated Development Environment) – A software application used for writing, compiling, and uploading code to Arduino boards.

Arduino Mega – A small programmable circuit board used to control electronic components.

Buck Converter – A device that lowers high voltage to a lower level, making it useful for safely powering electronic components.

Coin Hopper – A storage and dispensing device in a vending machine that holds coins and releases them when change is required.

Coin Slot (Universal Coin Acceptor) – A hardware module that detects, verifies, and accepts specific coin denominations for payment.

DC Motor Gear – A DC motor with a built-in gearbox that makes it spin slower but stronger, useful for robots and machines that need controlled movement.

Dispensing Mechanism – The mechanical system in a vending machine that physically releases the selected product.

ESP32 Wi-Fi Module – A microcontroller with built-in Wi-Fi and Bluetooth, enabling internet connectivity for IoT features such as inventory monitoring.

Firebase – A cloud-based platform by Google that offers real-time databases, hosting, and authentication services for applications.

Flowchart – A diagram that shows the step-by-step process of how a system or program works.

Infrared Sensor – A sensor that uses infrared light to detect objects, commonly used to confirm whether a vending item has been released.

IoT (Internet of Things) – A system where devices are connected to the internet, enabling data collection and remote monitoring.

Keyboard Keypad – An input device with buttons or keys that allows users to enter selections, such as product codes or menu options.

LCD2004A (Liquid Crystal Display) – A display module that shows messages, prices, and instructions to users.

Microcontroller – A small computer on a single chip that can control devices and execute programs, such as the Arduino.

Motor Driver (L298N) – An electronic circuit that controls the speed and direction of DC motors by acting as an interface between the microcontroller and motors.

Next.js – A React-based JavaScript framework used for building fast, server-rendered web applications.

Power Supply – A device that provides electrical power to the vending machine, converting AC power into DC power.

Prototype – The first working model of a project that demonstrates its design, features, and functionality.

Rechargeable Battery (12V 7A) – A power source that can be recharged and provides backup energy to the vending machine during power interruptions.

System Architecture – The structured framework of hardware and software components that defines how a system operates.

Testing – The process of running and evaluating a system to ensure it works correctly and meets the intended requirements.

Transaction – The process of a customer making a purchase, including inserting payment, selecting an item, and receiving the product.

Vending Machine Spring – A coiled metal mechanism that rotates to push an item forward, releasing it to the customer.

VS Code (Visual Studio Code) – A popular code editor used for programming in different languages, including C++ and JavaScript.

Workflow – The sequence of tasks or operations carried out to complete a process within the system.

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter discusses the different related literature and studies for the development of a school stationery vending machine for Cavite State University - Bacoor City Campus. This literature and study review aided the developers in gaining familiarity with and understanding of the topic.

Foreign Literature

DIY Automatic Water Vending Machine using Arduino

This project designed an Arduino-controlled vending system that dispensed water through a coin-operated mechanism. A coin acceptor module was used to detect pulses generated by valid coins, which the microcontroller then processed before activating a pump for a timed dispense. While the prototype focused on liquids, the logic behind coin validation and timed dispensing is directly applicable to stationery vending machines. The study clearly demonstrated how Arduino can manage coin-slot transactions and control dispensing mechanisms, offering a simple and cost-effective model that parallels inventory decrementing in multi-item vending (CircuitDigest, 2021).

Stationery Vending Machine Market Size, Share and Trends

The growth of self-service retail within schools is transforming or let's just say reshaping the market for stationery vending machines. Intelligent features like stocks sensors, and automatic restocking notifications have optimized these machines. Schools are also using rechargeable battery reduce operational expenses while fostering sustainability. Analysis of data helps in streamlining vending machine placements so that they are placed in areas with maximum traffic to maximize usage and returns (Verified Market Reports, 2024).

An Exploratory Implementation of Stationery Vending Machines in Educational Institutions

Schools are now relying more on vending machines to offer necessary supplies, eliminating the necessity for bookstores or administrative distribution. Real-time inventory management have now upgraded automated retail solutions to make necessary materials available to students at any moment. Challenges like technical failures and supply shortages still need ongoing improvements despite the benefits. The research also discusses hot IoT-based monitoring is optimizing the management of vending machines and reducing costs (Scribd Research Team, 2023).

Smart HygineMate Hub: A Smart Vending Machine

This study introduced a vending machine prototype that utilized a coin-acceptor module interfaced with an Arduino microcontroller to validate genuine coins and reject counterfeit ones. The system was primarily designed to dispense hygiene-related products, such as sanitizers and tissues, but the logic of its design is highly transferable to stationery vending applications. Both systems require the same fundamental process: coin validation, product selection, activation of a dispensing mechanism, and delivery of the item to the user. The researchers also integrated a simple IoT feature that enabled remote monitoring of inventory levels, allowing operators to track stock availability and prevent shortages. Although the product focus was different, the study demonstrated how a low-cost, hardware-driven vending machine could be efficiently deployed in schools and public spaces without relying heavily on expensive smart features. This makes it significant to stationery vending machines, as it provides a clear example of how Arduino-based coin validation and basic inventory tracking can be applied to student-centered solutions. The study further highlighted that while IoT integration improved monitoring, the essential framework coin-slot transactions and motor-driven dispensing remains the backbone of automated vending systems,

reinforcing the potential of adapting this model for affordable stationery distribution in educational institutions (International Journal of SRCSIT via ResearchGate, 2024).

DIY Vending Machine – Arduino-based Mechatronics Project

This project showcased a vending system built around an Arduino Uno microcontroller, where coin input was detected, validated, and then used to trigger a dispensing mechanism. Once a valid coin was inserted, the user pressed a button corresponding to their desired item, and the microcontroller activated stepper or servo motors to release it. The design emphasized the importance of transaction sequencing—coin validation, product selection, and mechanical actuation which serves as the foundation for nearly all vending machines regardless of the items being dispensed. Although the prototype was originally created as a general-purpose vending machine, its configuration mirrors the operational needs of stationery vending since it is centered on reliable coin detection, programmed transaction logic, and controlled dispensing mechanisms.

The study's significance lies in how it highlights Arduino as an efficient and affordable controller for small-scale vending systems, demonstrating that complex vending features such as AI recommendations or mobile payment are not always necessary to meet user needs. Its modular and low-cost approach makes it highly adaptable to school environments where budget-friendly solutions are essential. Moreover, the simplicity of the design provides an educational blueprint for developing functional vending prototypes without requiring advanced computing systems. This positions the study as highly relevant to stationery vending research, since it establishes a proven baseline framework of coin-slot validation and motor-based dispensing that can be directly applied to student-focused supply machines (HowToMechatronics, 2022).

Local Literature

Consumer Preferences Towards Vending Machine Products in University Campuses

A recent study conducted in several universities in Metro Manila examined how students perceive and use vending machines within the campus. The findings revealed that vending machines are considered affordable and convenient, especially during exam periods when students need quick access to snacks and other items. The study also emphasized that students value modern features such as real-time monitoring of stock availability and digital payment systems like GCash or PayMaya. While our project does not include cashless payment integration, this research remains relevant because it shows how IoT-based features such as inventory tracking can significantly improve vending machine operations in school settings. By focusing on IoT monitoring and coin-slot validation, our project addresses the same need for reliable access to supplies, but through a simpler and more affordable approach that matches the available hardware (Santiago and Villanueva, 2023).

Development of a School Supplies Vending Machine at Batangas Eastern Colleges

Developmental research in 2021 was conducted by a group of senior high school students of Batangas Eastern Colleges who undertook a pioneering effort to develop a vending machine specifically designed to dispense essential school supplies. Considering the ever-present issue of students forgetting or running out of essential supplies such as pens, pencils, and notebooks, the team aimed to create a convenient solution with easy access within the campus terrain. The vending machine was envisioned to dispense a variety of products from writing instruments, paper products, to other stationery essentials. The research referred to the potential benefits of such a machine, focusing on less time spent by students searching through supplies and fewer disruptions in the course of the day. The project also assessed the feasibility of the integration of payment systems to address the increasing use of digital payment facilities among the students. The project reaffirmed the potential to use technology in enhancing the academic experience through solving day-to-

day issues encountered by students (Arzadon et. al., 2021).

A Look at Stationery Vending Machines in Philippine Universities

This developmental study conducted by senior high school students of Polytechnic University of the Philippines aimed to create a vending machine specifically designed to dispense essential school supplies such as pens, pencils, and notebooks. The researchers addressed the recurring issue of students forgetting or running out of necessary materials during class hours and the inconvenience of walking long distances or waiting in line at bookstores. By introducing an automated vending machine inside the campus, they sought to provide a quick and accessible solution that would minimize class interruptions and improve student convenience. The study emphasized that placing vending machines in strategic school areas allows students to immediately access supplies without leaving their learning environment. While the research also discussed the possible integration of cashless systems, the main focus was on automation, convenience, and student accessibility (Mendoza et. al., 2022).

Improving School Facilities with Automated Supply Machines

This study explored the feasibility of installing automated vending systems for distributing essential school supplies within academic institutions. The researchers utilized microcontrollers and sensors to control the dispensing process, incorporating a coin-slot payment system and optional RFID support for added security. The vending machines were designed to provide quick and dependable access to common school items such as pens, paper, and notebooks minimizing the reliance on traditional bookstores that often have limited operating hours.

One of the key findings of the study was the importance of real-time inventory tracking and routine machine maintenance to ensure continuous operation, especially during peak

academic periods. The system's ability to monitor stock levels and detect low supplies helped prevent stockouts and improved service reliability. Furthermore, the research emphasized the integration of basic automation principles, including motor-driven dispensing, sensor-based detection, and microcontroller coordination, which are directly applicable to Arduino-based vending machines.

Overall, this study underscored the benefits of combining affordability, functionality, and accessibility in vending machine systems for educational environments. While it also discussed modern payment methods, its greater significance lies in demonstrating that simple coin-operated, microcontroller-powered systems can effectively meet student needs when paired with efficient design and monitoring. These insights provide a strong foundation for developing similar IoT-supported, low-cost stationery vending machines aimed at enhancing school convenience and operational efficiency (Garcia et. al., 2021).

Smart Vendi

Developed by a Philippine-based senior high school researcher, *Smart Vendi* was a thesis project that introduced a portable school supply vending machine designed to dispense pencils, pens, writing pads, and bond papers. The system operated using an Arduino Uno microcontroller and C++ programming, with an LCD screen and keypad for item selection, a coin-operated payment system, and motor-driven dispensing coils.

The vending machine was notable for its battery-powered portability, operating on a 12 V setup made from standard 1.5-volt batteries. It featured a DIY casing built from lightweight materials such as acrylic and gypsum board and was calibrated to accept both old and new Philippine peso coins. Despite its low cost of around ₱4,670, the project successfully provided a user-friendly and accessible solution for dispensing school supplies and received recognition for innovation and practicality.

This study demonstrates the feasibility of low-cost, Arduino-based vending systems that rely on coin validation, motor control, and basic user interfaces serving as a strong reference for similar projects that prioritize affordability and accessibility in educational environments (mschvx et. al., 2022).

Foreign Studies

Integration IoT in Intelligent Vending Machines

This particular research explores the enhancement of vending machines through the integration of the Internet of Things (IoT). Instead of relying on artificial intelligence, the study emphasizes how IoT-based features such as real-time inventory monitoring, predictive maintenance alerts, and remote access improve both customer experience and operational efficiency. Through sensors and microcontrollers, vending machines can automatically notify operators when supplies are running low, preventing shortages during peak demand. The integration of IoT also enables data logging, where transaction records and usage frequency can be stored for future analysis, helping schools and businesses decide on product placement and restocking schedules. The study highlights that even with basic components such as coin acceptors, DC motors, and microcontrollers like Arduino IoT connectivity can be added to provide remote monitoring without significantly increasing costs. This demonstrates how IoT can complement traditional vending systems by improving reliability and ensuring that essential items, such as school supplies, are always available for students (IMARC Group, 2023).

Intelligent Vending Machines Market Future Prospect Forecast 2033

This study investigates the future development and growth of intelligent vending machines, with a focus on enhancing vending technologies through AI-driven product suggestions, touchless interfaces, and smartphone integration. It explores advancements in machine design aimed at improving customer interaction, hygiene, and operational efficiency.

The research emphasizes projected market trends, sustainability features, and user convenience across various sectors, including education and retail. Findings highlight significant innovation potential and increased demand for contactless, smart vending solutions (Straits Research, 2024*).*

Development of Smart Stationery Vending Machines for Educational Institutions

This study focuses on the development and implementation of smart vending machines designed for dispensing stationery in schools and universities. It highlights the integration of IoT technology for real-time inventory management, automated restocking alerts, and remote diagnostics. The research discusses the system's design process, including hardware setup, user interface programming, and testing across various educational institutions. Results show that the developed system improved accessibility to essential school supplies and minimized maintenance downtimes (Data Horizon Research, 2024).

Stationery Vending Machine

This particular research centers on the design and development of an automated stationery vending machine powered by an Arduino microcontroller. Created to dispense a wide array of stationery products without manual assistance, the machine is engineered to operate efficiently in fast-paced school environments. The researchers compare and analyze various design factors—including physical size, transaction speed, and power efficiency—to arrive at an optimized vending machine design capable of dispensing both light and heavy items with minimal error (IJNRD, 2023).

Local Studies

Basic School Supplies Dispenser with Single Transaction Payment

This research focused on designing a simple school supplies vending machine that distributed stationery items such as yellow booklets, black ball pens, and pencils. Using a coin-slot payment system, the dispenser allowed students to select items through an intuitive interface and receive them immediately. The study emphasized its role in reducing long queues in bookstores by offering a convenient automated alternative. Researchers observed positive feedback from students regarding its ease of use, though many recommended expanding the variety of available products (Detablan, Marquez, and Refre, 2021).

Development of School Paper and Ballpen Vending Machine Using Arduino Uno

A senior high school research project that developed a vending machine dispensing yellow paper sheets and ballpoint pens. The system used Arduino Uno, LCD1602 display, mechanical coin detection, and push-button operation for item selection. Dispensing was controlled via DC motors, and power was managed using a 12 V battery and buck converter setup. No AI, smart payment, or internet connectivity was utilized highlighting mechanical simplicity and educational usability (Casimero, V. et. al. 2024).

Development of an Automated School Supplies Vending Machine

This capstone introduces an Arduino Uno–based vending machine designed to dispense essential school supplies like pens, paper, notebooks, index cards, and yellow bond paper. The system is engineered with five compartments each equipped with a motor that rotate upon user selection to deliver the chosen item. The design integrates sensors, an LCD interface, and motor driver circuits to streamline transactions, operating 24/7 on campus to save students time and effort otherwise spent traveling to purchase supplies. Coin sensors

handle payment validation, and the Arduino controller orchestrates the dispensing process via an intuitive flow chart mechanism. The proposal also outlines the system's hardware components (Arduino Uno, coin sensor, DC motors, LCD, power supply) and emphasizes the anticipated campus impact, such as providing immediate access to supplies (Mahinay, R.K.C. and Mosquera, I.J.Q. 2023).

Automated Test Booklet Vending Machine

This research is based on the construction of an automatic vending machine used to distribute test booklets among students. The machine has a coin-slot type and is managed by an ATmega328 microcontroller. It features a servo motor-based coin dispenser and a coin storage compartment for giving change. The interface between the machine and the user is through a keypad and outputs are shown using a Liquid Crystal Display (LCD). The prototype was tested for functionality, efficiency, reliability, and accuracy, and there were positive comments from the respondents (Jane Beatriz Causapin, Zhannel Maevierize Go, Kim Stuart Lacson, Michael Andrew Mendoza, John Paul Modrigo 2021).

Synthesis

From the different related literature and studies, both foreign and local, it is clear that school stationery vending machines are becoming increasingly important in academic institutions. CircuitDigest (2021) and HowToMechatronics (2022) highlighted that Arduino-based vending machines using coin validation, motor-driven dispensing, and simple transaction logic can already provide reliable and cost-effective solutions without the need for advanced technologies. Verified Market (2024) and Scribd Research Team (2023) further pointed out that the vending machine industry is moving toward improvements such as real-time stock monitoring and better placement strategies, showing how IoT can optimize vending operations and reduce shortages. These findings support the relevance of integrating IoT into vending machines for educational use.

Looking at other foreign studies, the International Journal of SRCSIT (2024) demonstrated that low-cost vending machines with Arduino controllers and coin acceptors can be effectively combined with IoT monitoring to maintain inventory levels in schools. IMARC Group (2023) also stressed that IoT-based monitoring systems allow machines to notify operators about low supplies, ensuring uninterrupted service. These examples reinforce that even without smart payments or artificial intelligence, IoT features can strengthen vending machine reliability.

In the Philippine context, Santiago and Villanueva (2023) observed that students see vending machines as affordable and convenient, especially during exams, and while they highlighted interest in cashless payments, the IoT aspect of monitoring and ensuring supply availability is directly relevant to projects like ours. Arzadon et. al. (2021), Mendoza et. al. (2022), and Garcia et. al. (2021) all worked on school supply vending prototypes using Arduino controllers, coin-slot systems, and simple dispensing mechanisms, showing that hardware-based designs remain practical and beneficial for campus use. Detablan, Marquez, and Refre (2021), Casimero et. al. (2024), Mahinay and Mosquera (2023), and Causapin et. al. (2021) also provided examples of local projects that addressed immediate student needs through coin-operated school supply, paper, and test booklet vending systems. The Smart Vendi project (mschvx et. al., 2022) further demonstrated a portable, low-cost, Arduino-based vending system for pencils, pens, and writing pads, reinforcing the feasibility of accessible and affordable vending solutions in Philippine schools.

In conclusion, both foreign and local literature agree that vending machines play a valuable role in ensuring students have quick access to supplies, especially during busy academic periods. While some studies explore advanced features like cashless systems or AI, our project focuses on IoT-enabled inventory monitoring and coin-slot validation using Arduino, motor drivers, and other accessible components. This creates a simpler, affordable, and campus-ready vending solution tailored to Cavite State University–Bacoor City Campus.

Systems Technical Background

Coin Detector examined coin payment systems in vending machines, which validate coins based on programmed attributes. These systems integrate mechanical and electrical technology to assure compliance with payment standards and execute transactions rapidly (Murena et. al. 2020).

Arduino Arduino is a commonly used platform in vending machine design. It processes inputs and controls outputs such as motors and LED displays. Users can program Arduino boards to customize machine functions, making them adaptable to different needs. Recent studies highlight the role of Arduino in improving vending machines by enabling real-time stock tracking, cashless payments, and remote management. These features enhance efficiency and make vending machines more responsive to users (Ratnasri and Sharmilan, 2021).

Developed a vending machine with advanced features, including fingerprint security, multiple product options, and an advertising system. These additions improved accessibility and security while keeping costs manageable. Kishore (2022) introduced a portable vending machine that dispenses essential items like pens and sanitary products. The study emphasized its efficiency, low power consumption, and suitability for areas with limited automated supply options (Sibanda et. al. 2020).

Arduino Uno R3, a widely used microcontroller board, plays a key role in automation and embedded systems. It includes digital and analog input/output options and operates with low power. Its adaptability makes it useful for research and education. Mumtaz et. al. (2021) explored its application in smart city projects, demonstrating its effectiveness in automation tasks such as street lighting and traffic monitoring.

The University of California studied the role of vending machines in schools, focusing on how they improve access to supplies and influence students' purchasing habits. These findings

support the growing use of vending machines as a practical solution in educational settings (2020).

12V Power Supplies A 12V stable power supply is essential for vending machines, supplying power to elements like LCDs, servo motors, and microcontrollers. Aung et. al. in a 2020 study identified the application of a rectifier circuit within a vending machine to deliver a stable DC voltage, while a DC-to-DC converter steps down 12V to 5V to supply devices that need lower voltage. Appropriate voltage regulation avoids overheating and extends the lifespan of electronic devices (Aung et. al 2020).

C++ is the main programming language employed in Arduino development, offering flexibility to write firmware and manage hardware elements. Arduino's C++ based syntax enables developers to work with sensors, motors, and actuators efficiently. study focused on the role of C++ in embedded systems, highlighting its structured programming, low-level access to hardware, and real-time processing features (Kumar et. al. 's 2021).

C++ is vital for interrupt handling, real-time data processing, and memory optimization in microcontroller-based systems. Its object-oriented nature makes it possible for modular programming, allowing scalable and maintainable complex Arduino projects.

Arduino IDE The Arduino Integrated Development Environment (IDE) is the main software for programming Arduino boards. It accommodates C++/C-based programming, providing an easy-to-use interface, integrated libraries, and debugging facilities. study that the Arduino IDE made embedded system development easier, making it easier for students and professionals to use (Alam et. al. 2022).

LCD Screens play a critical role in the provision of intuitive interfaces in vending machines. LCDs show immediate feedback, for example, availability of products, prices, and transaction status, enhancing user experience. A study conducted explained the building of an Arduino-based vending machine that utilized an LCD to facilitate efficient operation. The

study indicated that clear and quick displays ease the navigation of choices by users, minimizing mistakes and enhancing convenience (Rijad et. al. 2024).

Servo Motors are important in the exact control of mechanical parts, e.g., dispensing mechanisms of vending machines. A study utilized servo motors to manage the release of the product to provide accuracy and effectiveness. The microcontroller triggers signals to the servo motor for the ability to precisely move and dispense the proper item. Servo motors are used over other options because of their high torque, low energy consumption, and accurate positioning, which suits them for use in automation (Aung et. al. 2020).

Microcontrollers act as the heart of the vending machine, regulating inputs from sensors, coin slots, and buttons and controlling outputs such as servo motors and LCDs. Arduino Mega, applied in research, controlled the entire function of a vending machine, handling transactions and regulating components with ease. Microcontrollers play a crucial role in facilitating automated decision-making, increasing speed, and minimizing errors in vending machines (Aung et. al. 's 2020).

Buttons are the main form of user input in vending machines to enable customers to choose products, make payments, and step through options. Kumar et. al. investigated the use of push buttons and capacitive touch buttons in vending machines and their significance in providing accurate and timely user input study (Kumar et. al 2022).

Momentary push buttons are the prevalent switches utilized in Arduino-based vending machines, wherein each touch activates a signal for the microcontroller that elicits the respective action. A study underlined that debouncing methods (like software filtering or hardware-based capacitors) are required to avoid unwanted multiple inputs to ensure smooth functionality (Patel et. al. 2023).

METHODOLOGY

This chapter includes the design and development of the vending machine, system testing, evaluation, data analysis, and implementation plan of the study.

Design of Software, Systems, Product, and Processes

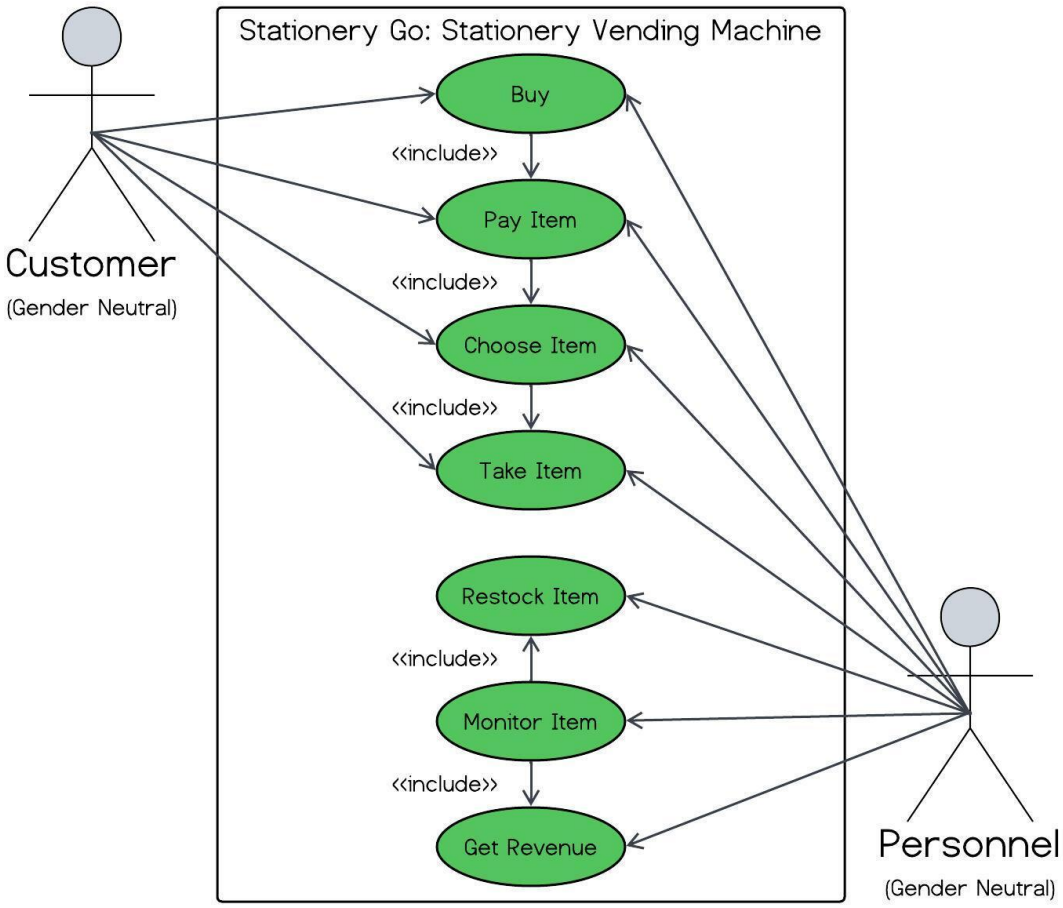


Figure 2: Use case diagram of the stationery vending machine

Figure 2 shows when a customer makes a purchase, the mandatory steps include selecting an item, paying for it, and retrieving the item. These steps are essential to complete a successful transaction. Maintenance personnel are responsible for setting up the machine and monitoring its operation. As part of monitoring, they must check item availability and

collect revenue. If an item's quantity is low, they must restock it to ensure continuous availability.

Requirements Analysis

This chapter evaluates the software development life cycle, with the proponents embracing the Incremental Prototyping method that will guide the project's progress and ensure that it is completed effectively.

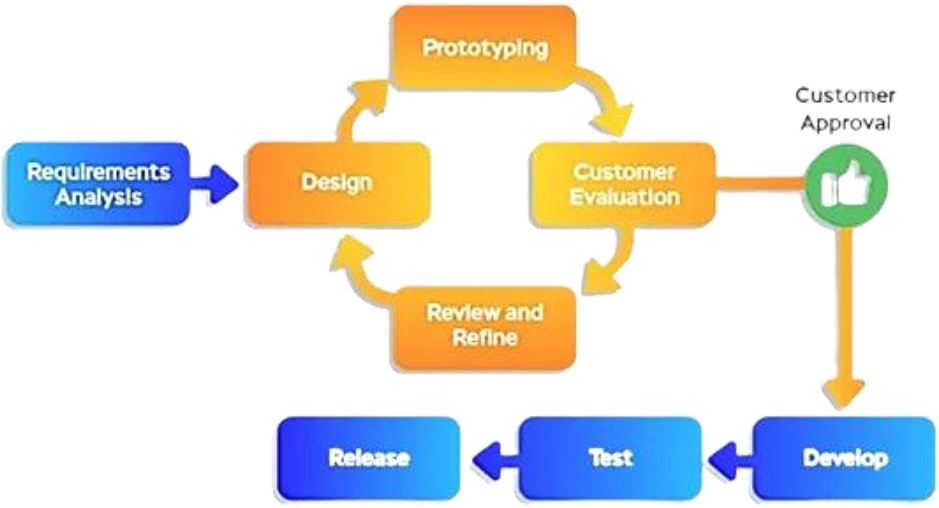


Figure 3. Incremental Prototyping

Requirement Gathering and Analysis:

During this phase, the project requirements were identified by analyzing the fundamental needs of a coin-based stationery vending machine. Key aspects such as secure and accurate coin validation, a reliable dispensing mechanism, a user-friendly interface, and a sturdy frame were considered. The research was conducted to understand common issues in vending machines, including coin jamming, mechanical failures, and user accessibility, ensuring that the design addresses these challenges effectively.

The researcher started by reviewing existing vending machine technologies and identifying common issues from real-world failures, such as coin rejection and dispensing

errors. To guide the project, they surveyed available courses, faculty members, and administrative staff at CvSU Bacoor and gathered insights through hands-on research to determine the hardware and software needed. From this, they defined the key features that a vending machine must have: coin validation, product list, product selection, and reliable dispensing. To further support the system design, an analysis report was conducted to examine existing vending technologies and their recurring issues. The findings can be found in (see Appendix Table C).

Initial Design and Prototype Development (Core Functionalities):

The prototype was developed to integrate the essential components needed for the vending machine's operation.

The researcher built the initial frame of the vending machine (see Appendix K. Prototype Testing V1) and installed the coin validator, dispensing system, and user interface. Basic software was developed to handle coin recognition and product selection. Initial testing (see Appendix Figure 5.) was then conducted to ensure proper coin acceptance and accurate item dispensing.

Prototype Testing and User Feedback:

The development phase assembles and tests the physical components of the vending machine, including its frame, dispenser mechanisms, control system, and coin payment system, to verify their functionality (see Appendix L. Prototype Testing). Additionally, the software functionalities are extensively tested to ensure reliability and accuracy. Once both hardware and software components are validated, they are integrated to ensure seamless operation, enabling the vending machine to function as a seamless and efficient system.

The researcher tested all physical components, including the frame, dispenser, control system, and payment mechanism, to ensure stability and functionality. The software was also

verified for accuracy in processing transactions. Additionally, they gathered user feedback to evaluate the machine's overall usability and identify areas for improvement.

Refinements and Enhancements:

Based on the feedback and test results, the prototype was refined to enhance its functionality and durability. The coin acceptor mechanism was improved to reduce the chances of incorrect validation and coin rejection errors. The dispensing system was optimized for smoother operation and jam prevention, ensuring reliability over extended use. Additional refinements, such as clearer LED indicators and reinforced structural materials, were introduced to enhance user experience and security against tampering (see Appendix Figure 15).

The researcher upgraded the coin validation system to minimize rejection errors and optimized the dispensing mechanism to prevent product jams. The machine structure was reinforced for increased durability and tamper resistance. They also enhanced the LED indicators and user guidance to improve accessibility and ease of use.

Extended Testing and Final Adjustments:

The refined prototype underwent extended real-world testing to evaluate its reliability over multiple transactions. This phase included stress testing the machine under various conditions, such as handling different coin conditions (new, old, slightly worn) and assessing the durability of moving parts over repeated use. Security aspects were also checked to ensure tamper resistance and protection against misuse. Any remaining issues identified during this stage were addressed through final adjustments before deployment.

They conducted stress testing to assess the machine's long-term durability and evaluated its response to various coin conditions, including new, old, and slightly worn coins. Minor mechanical and software bugs were identified and resolved to ensure smooth operation before deployment.

Deployment and Maintenance:

The vending machine was installed in its designated location, and ready for use. Regular maintenance checks were scheduled to prevent coin jams, mechanical issues, and system failures.

The researcher finalized the deployment and activated the vending machine for public use. Alongside the physical setup, they also deployed the software on a free cloud hosting platform to ensure remote access, monitoring, and updates.

Requirement Analysis:

In this phase, the researchers acquired extensive information on both the functional and non-functional requirements necessary for developing the coin-based school stationery vending machine. By utilizing the incremental prototyping technique, the system was continuously modified over numerous iterations depending on the feedback of chosen respondents. To guarantee that the system addressed real-world concerns, the researchers investigated existing vending machine technology and identified recurring issues such as coin validation errors, dispensing failures, maintenance downtime, and inventory anomalies. These discoveries constituted the foundation for strengthening the proposed system's architecture, functionality, and performance. The requirements received from respondents and the literature research guided each stage of development, ensuring that every prototype iteration fulfilled user needs and improved upon the previous version. Through this iterative process, the system was able to evolve into a dependable, efficient, and user-centered vending solution for Cavite State University – Bacoor City Campus.

Designing

In this step, the researchers designed both the hardware and software components of the coin-based school stationery vending machine based on the obtained requirements.

The goal was to build a practical, dependable, and user-friendly system that efficiently distributes supplies such as ballpens, correction tapes, and markers within the university.

The researchers employed the incremental prototyping technique, which allowed continual improvement of both hardware and software through testing and feedback until the final version attained the necessary performance and dependability.

The hardware design featured the Arduino Uno microcontroller, I2C LCD display, coin slot mechanism, DC motors, L298N motor driver, and coin hoppers for ₱1 and ₱5 denominations. These components were incorporated to enable precise coin validation, correct dispensing, and reliable change processing. The physical framework of the machine was designed to be durable, secure, and easy to repair.

The software was developed using the Arduino IDE and incorporated logical programming for coin detection, validation, and product dispensing. It also incorporated error-handling functions for rejected coins and stuck items to preserve smooth operation.

An LCD display was added to provide a clear and easy interface, indicating item prices, entered amounts, and transaction status. Maintenance capabilities, such as refill warnings and transaction monitoring, were also introduced. Through continual design changes and prototype assessments, the vending machine grew into an efficient, dependable, and user-centered system that met both functional and usability objectives.

Building

After finalizing the system design, the researchers proceeded with the building and integration of the hardware and software components of the coin-based school stationery vending machine. The incremental prototyping paradigm led this step, allowing each subsystem to be constructed, tested, and improved in cycles before the entire system integration.

The hardware assembly includes attaching the Arduino Uno microcontroller, coin slot, I2C LCD display, L298N motor driver, DC motors, and coin hoppers for ₱1 and ₱5 denominations. These components were securely attached in the machine's frame to provide smooth and precise coin validation, item dispensing, and change dispensing operations.

The software was created using Arduino IDE, where logic for coin validation, product selection, and dispensing control was developed. The code was regularly modified depending on test results and user comments during prototype evaluation. The mechanical design was evaluated for stability, appropriate alignment of motors, and smooth dispensing mechanisms to prevent jams or dispensing errors. Each prototype iteration focused on improving system reliability, reducing mechanical errors, and ensuring accurate coin recognition. Once all essential components were functioning effectively, the system was fully assembled and set up for final testing and assessment.

Testing

The testing phase focused on verifying the system's functionality, reliability, and user interaction. Each component and subsystem was independently tested before completing full system integration tests. The researchers performed several trials involving coin validation, product dispensing, and change return to ensure accurate and consistent performance. Test cases were undertaken to test the acceptance of valid coins, rejection of counterfeit or invalid coins, and correct dispensing of products following a successful transaction. The vending machine's interface was also tested to confirm that the display provided clear transaction feedback and user instructions.

Mechanical testing was undertaken to check for alignment difficulties, dispensing delays, and any jams. The testing procedure followed the incremental approach, where flaws detected in previous prototypes were addressed and re-evaluated in successive versions.

This iterative technique verified that all system functions satisfied the intended requirements before final implementation.

System Testing

The system was tested to ensure that all components and software modules functioned harmoniously as an integrated unit. The researchers conducted end-to-end testing by replicating real-world transactions, including item selection, coin insertion, and dispensing of both products and change.

Testing also includes mistake situations such as coin rejection, inadequate balance, and limited product stock. The reliability of the vending machine was examined by many continuous transactions to measure its durability and performance under repeated use.

During system testing, the vending machine proved effective coin validation, accurate change dispensing, and proper item release with minimal mechanical issues. This phase ensured that the final prototype met the functional and non-functional requirements specified during the analysis step.

Implementation Plan

Table 2 shows the implementation plan outlining the strategies, activities, persons involved, and duration required for the successful installation and evaluation of the vending machine project.

Table 1. Implementation plan

STRATEGY	ACTIVITIES	PERSONS INVOLVED	DURATION
Approval from the University Administration	Submission of a formal request for campus installation approval.	Researchers, Campus Administrator	1 Day
System Installation	Setup of vending machine hardware and software components.	Researchers, Campus Administrator	5 Hours
Information Distribution	Distribution of posters and flyers to promote machine awareness and usage.	Researchers, Administrative Staff	1 Day
Orientation and Demonstration	Conducted a short training on operation and maintenance.	Researchers, Administrator, Faculty Representative	1 Day
Evaluation and Feedback Gathering	Gathered evaluations from students, faculty, and IT professionals.	Researchers, Evaluators, Participants	3 Days

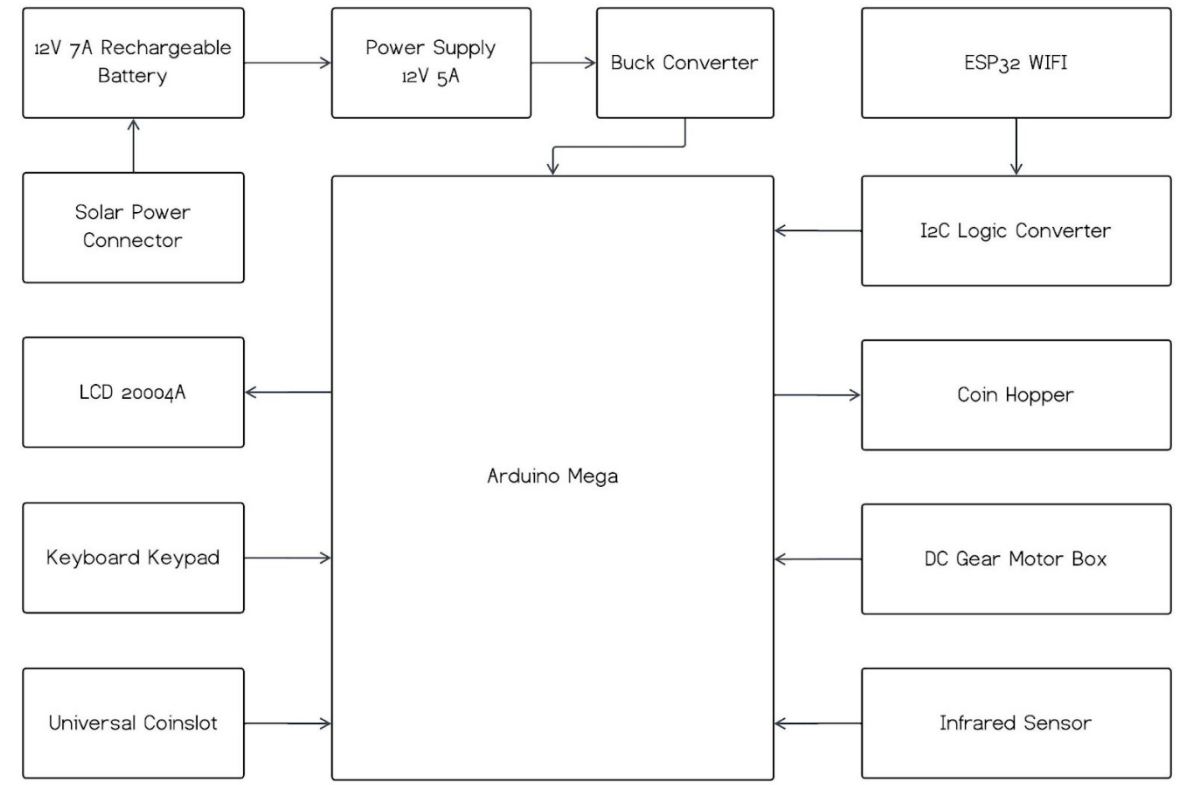


Figure 5: Block Diagram

Figure 5 shows illustrates the block diagram of our system, depicting the components and their interconnections. The system is powered by a power supply, which is regulated using a buck converter to provide appropriate voltage levels to the components. The Arduino Mega serves as the central controller, receiving inputs from the universal coin slot and push buttons while displaying information on an LCD screen. It controls various actuators, including servo motors and a DC motor driver, which in turn operate DC motor gears responsible for dispensing different stationery items. When a valid coin is inserted and a selection is made, the corresponding motor mechanism is activated to dispense the chosen item, such as a ballpen, paper, or correction tape. This structured design ensures efficient and automated dispensing, enhancing user convenience.

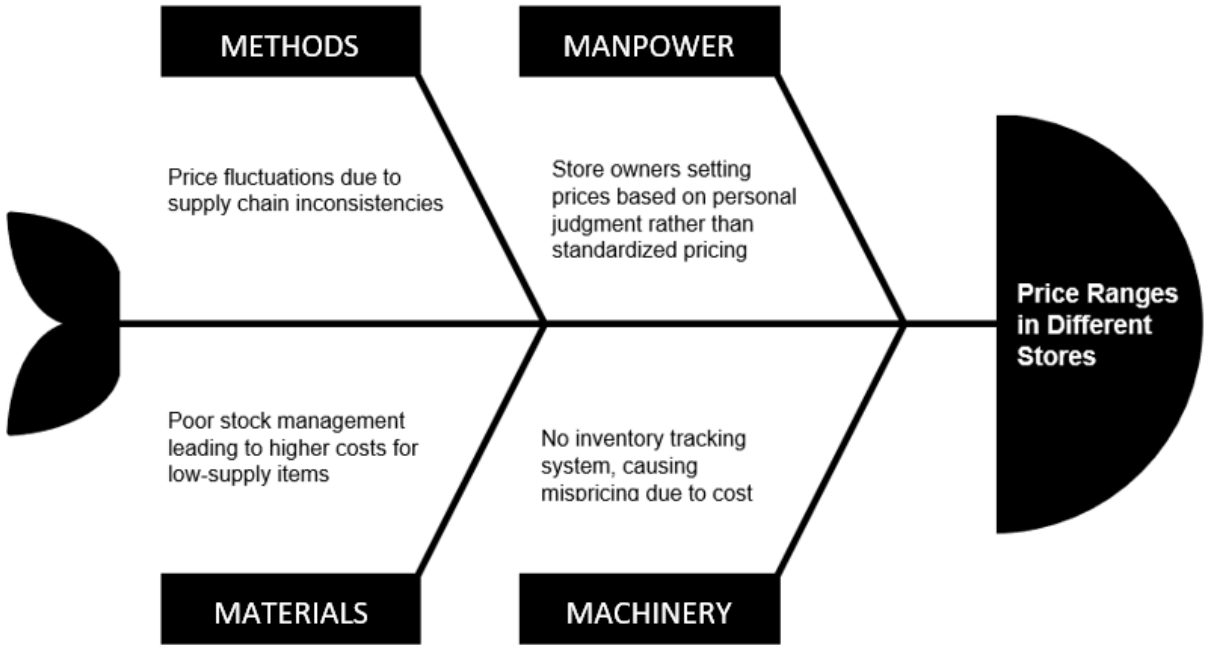


Figure 6: Long Queues during Peak hours in Sari-sari Store

This figure shows the common reasons behind long lines in sari-sari stores during busy hours. One reason is the limited number of staff, which slows down service when many customers arrive at once. There is also no separate line for small purchases, so all customers have to wait in the same queue. Cashiers calculate totals manually, which takes more time. Items are not arranged well, making it harder to find what is needed quickly. These issues cause delays and may lead customers to leave or avoid returning. Solutions may include adding staff, creating a separate lane for quick buys, and arranging products in a more organized way.

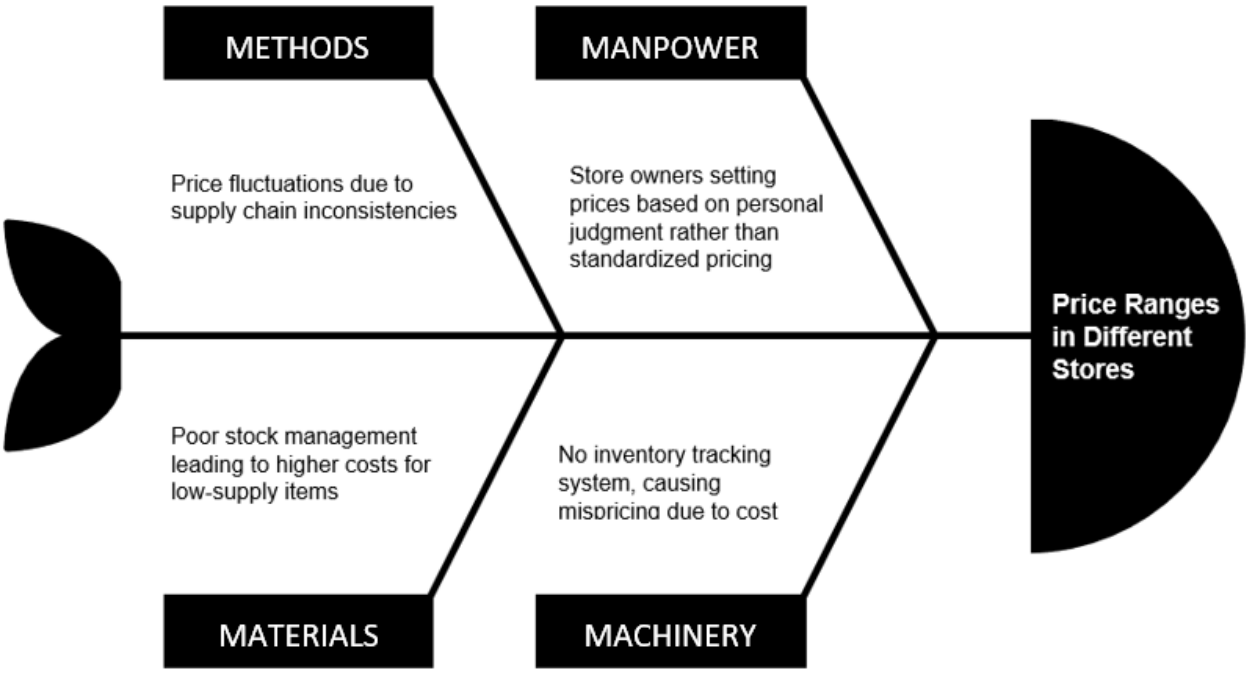


Figure 7: Price Ranges in Different Stores

This figure highlights the reasons behind price differences across sari-sari stores. Store owners often decide prices based on personal judgment, which leads to inconsistencies. Changes in supply also affect prices, especially when items become harder to get. Without inventory systems, some stores may not update their prices regularly. Poor stock management can also lead to higher prices for items that are running low. These factors make it harder for customers to know what to expect when buying from different stores. Setting standard prices, keeping better track of inventory, and improving coordination with suppliers may help reduce these differences.

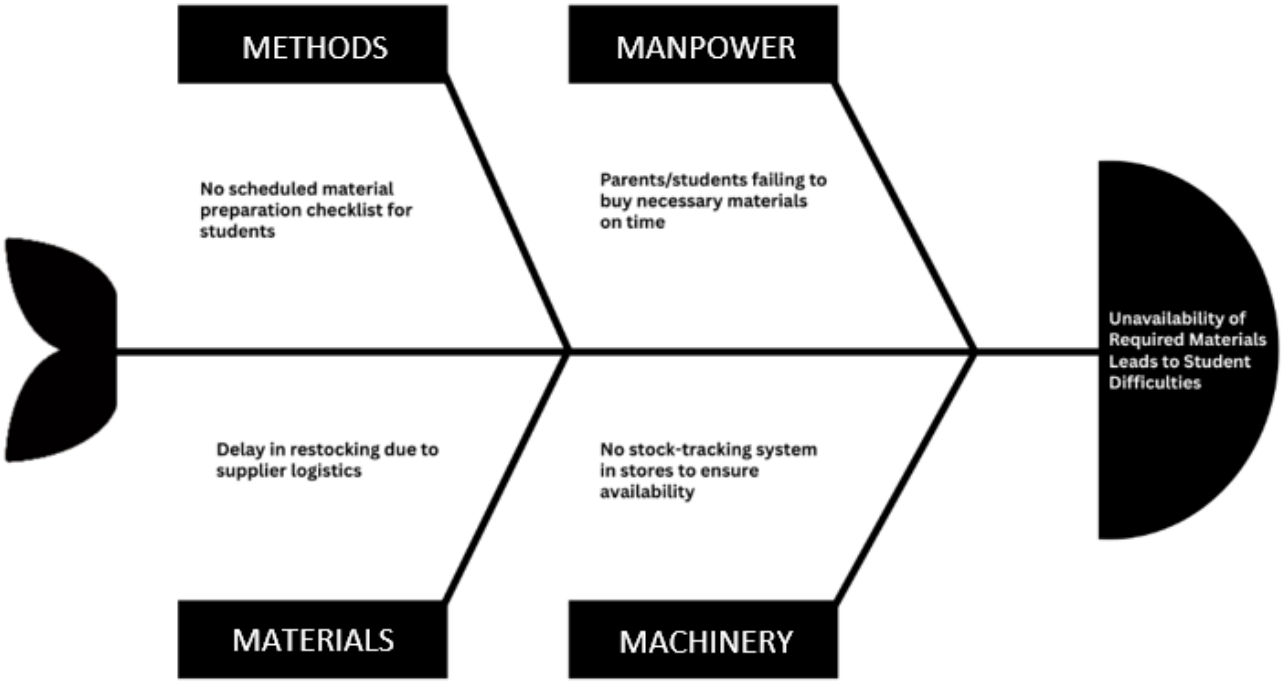


Figure 8: Unavailability of Required Materials Leads to Student Difficulties

This figure shows how students may be unprepared due to a lack of school supplies. Some families delay buying materials, either due to uncertainty or late planning. In some cases, schools do not provide a clear list of required items early enough. Local stores often do not track their stock properly, which can lead to shortages. When supplies run out, restocking may be delayed because of supplier schedules. These issues make it harder for students to complete schoolwork and stay engaged. Early planning, better communication from schools, and improved inventory practices in stores can help make materials more available.

APPENDICES

Appendix A. Approved Title Feedback Form

Republic of the Philippines
CAVITE STATE UNIVERSITY
Bacoor City Campus
SHIV, Molino VI, City of Bacoor
(046) 476-5029

DEPARTMENT OF COMPUTER STUDIES

DCIT 60: Methods of Research
First Semester, AY 2024 – 2025

APPROVED TITLE FEEDBACK FORM

Approved Title:	**STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY – BACOOR CITY CAMPUS**
Researchers:	**BUENO, STEPHEN CHESTER V.** **TALACAY, JEMMANUEL A.** **VALENZUELA, VLADIMIR**
Panel Members:	**DONNALYN B. MONTALLANA, MIT** **JOVELYN D. OCAMPO, MIT** **EDAN A. BELGICA**
Feedback:	• **Coin Out (refund)** • **Scanner (depicted item validator)** • **Storage Compartment (for defective items)**

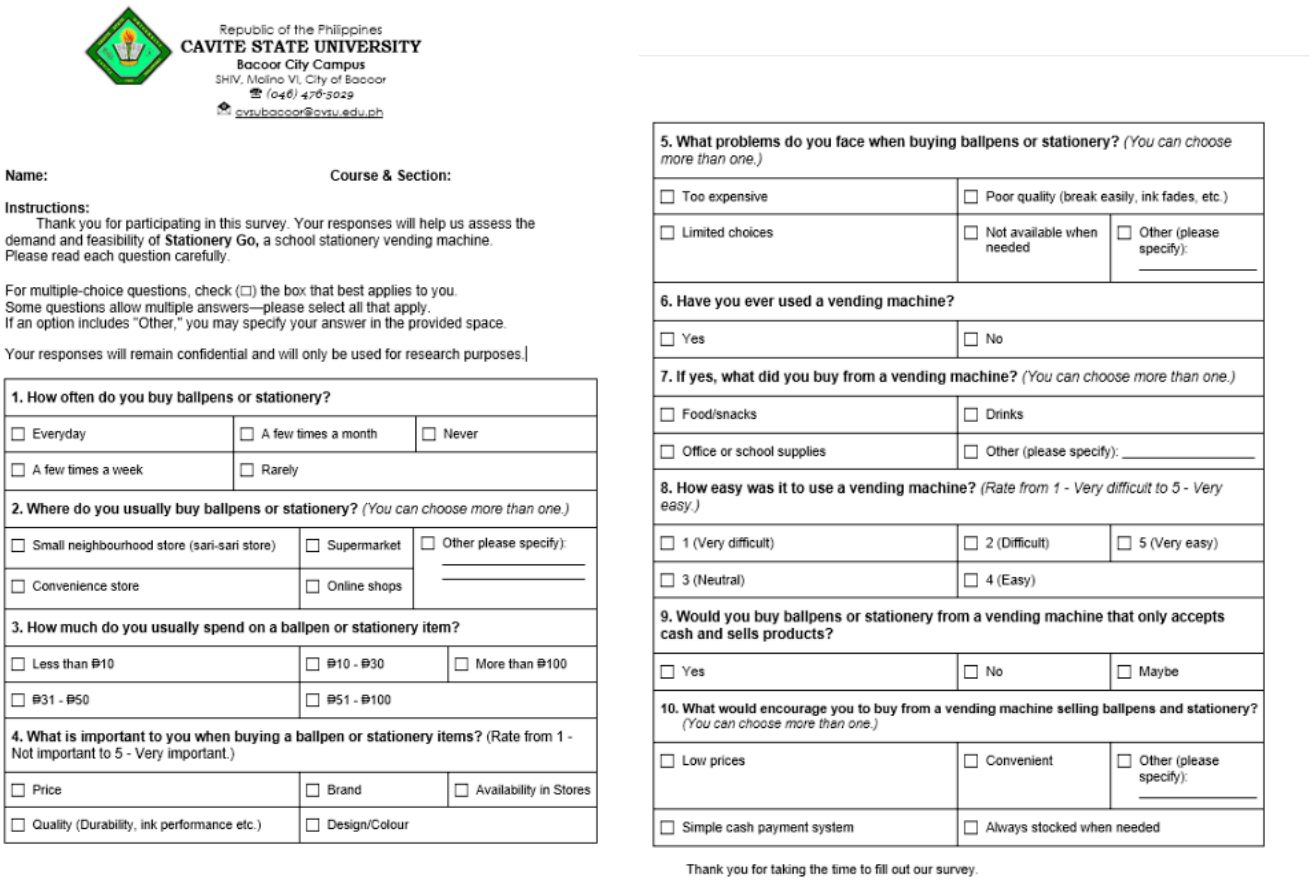
Appendix B. List of Hardware and Software Components

List of Hardware and Software Components

Category	Component
Hardware	Vending Machine Aluminum Frame
	Arduino Mega
	ESP32 WiFi Module
	DC Gear Motor Box
	DC Motor Gear
	Vending Machine Spring
	LCD20004A Display
	Universal Coinslot
	Coin Hopper
	Infrared Sensor
	Power Supply
	Buck Converter
	Keyboard Keypad
	12V 7A Rechargeable Battery
Software	C++ 23
	Arduino IDE 2.3.4
	Next.js
	Firebase
	Visual Studio Code (VS Code)

Appendix Table A. List of Hardware and Software Components

Appendix C. Survey Questionnaire for Data Gathering



Republic of the Philippines
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SHIV, Molino VI, City of Bacoor
☎ (046) 476-5029
cvsubacoor@cvsu.edu.ph

Name: **Course & Section:**

Instructions:
Thank you for participating in this survey. Your responses will help us assess the demand and feasibility of **Stationery Go,** a school stationery vending machine. Please read each question carefully.

For multiple-choice questions, check (☐) the box that best applies to you.
Some questions allow multiple answers—please select all that apply.
If an option includes "Other," you may specify your answer in the provided space.

Your responses will remain confidential and will only be used for research purposes.

1. How often do you buy ballpens or stationery?		
☐ Everyday	☐ A few times a month	☐ Never
☐ A few times a week	☐ Rarely	
2. Where do you usually buy ballpens or stationery? *(You can choose more than one.)*		
☐ Small neighbourhood store (sari-sari store)	☐ Supermarket	☐ Other please specify): _____
☐ Convenience store	☐ Online shops	
3. How much do you usually spend on a ballpen or stationery item?		
☐ Less than ₱10	☐ ₱10 - ₱30	☐ More than ₱100
☐ ₱31 - ₱50	☐ ₱51 - ₱100	
4. What is important to you when buying a ballpen or stationery items? (Rate from 1 - Not important to 5 - Very important.)		
☐ Price	☐ Brand	☐ Availability in Stores
☐ Quality (Durability, ink performance etc.)	☐ Design/Colour	

5. What problems do you face when buying ballpens or stationery? *(You can choose more than one.)*		
☐ Too expensive	☐ Poor quality (break easily, ink fades, etc.)	
☐ Limited choices	☐ Not available when needed	☐ Other (please specify): _____
6. Have you ever used a vending machine?		
☐ Yes	☐ No	
7. If yes, what did you buy from a vending machine? *(You can choose more than one.)*		
☐ Food/snacks	☐ Drinks	
☐ Office or school supplies	☐ Other (please specify): _____	
8. How easy was it to use a vending machine? *(Rate from 1 - Very difficult to 5 - Very easy.)*		
☐ 1 (Very difficult)	☐ 2 (Difficult)	☐ 5 (Very easy)
☐ 3 (Neutral)	☐ 4 (Easy)	
9. Would you buy ballpens or stationery from a vending machine that only accepts cash and sells products?		
☐ Yes	☐ No	☐ Maybe
10. What would encourage you to buy from a vending machine selling ballpens and stationery? *(You can choose more than one.)*		
☐ Low prices	☐ Convenient	☐ Other (please specify): _____
☐ Simple cash payment system	☐ Always stocked when needed	

Thank you for taking the time to fill out our survey.

Appendix Figure 1. Survey questionnaire distribution among Cavite State University students to gather data on purchasing habits, preferences, and challenges in buying pens and stationery items, serving as the basis for the design and development of the vending machine project.

Appendix D. Request for Adviser and Technical Critic

Republic of the Philippines
CAVITE STATE UNIVERSITY
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DEPARTMENT OF COMPUTER STUDIES

REQUEST FOR ADVISER AND TECHNICAL CRITIC

Name of Researcher(s) : **BUENO, STEPHEN CHESTER V.**
TALACAY, JEMMANUEL A.
VALENZUELA, VLADIMIR

Program : **BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY**

Title of Study : **STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY – BACOOR CITY CAMPUS**

CONFORME:

DONNALYN B. MONTALLANA, MIT — Adviser — 1/23/25 Date
EDMUND C. MARTINEZ — Technical Critic — 1/23/25 Date

RECOMMENDING APPROVAL:

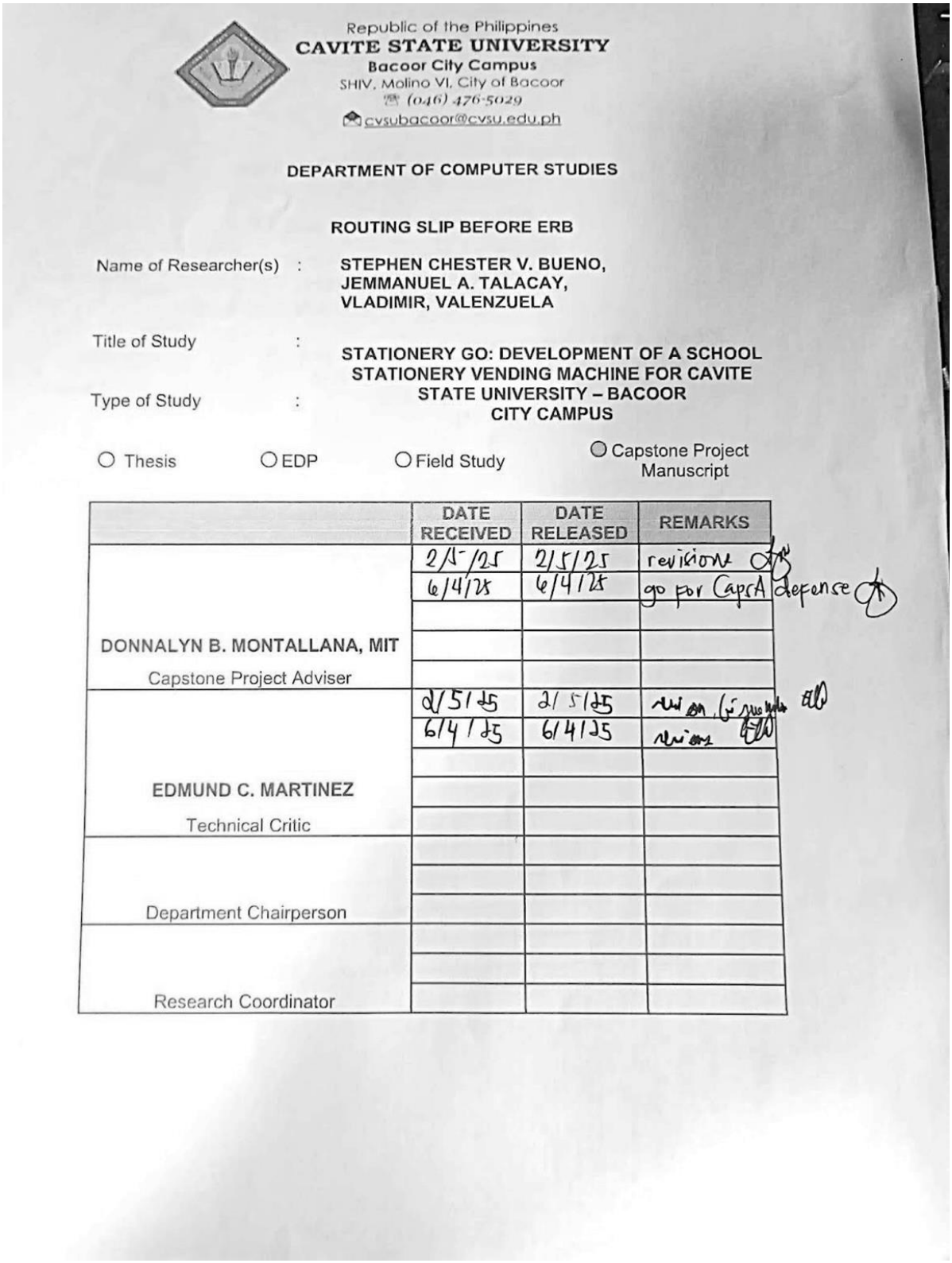
JOVELYN D. DCAMPO, MIT — Department Chairperson — 1/23/25 Date
RONAN M. CAUIGAL, MAEd — Campus Research Coordinator — 1/23/25 Date

APPROVED:

MENVYLUZ S. MACALALAD, MBA — Campus Administrator — 1/23/25 Date

cc: capstone project instructor, adviser, technical critic, research coordinator, student

Appendix E. Routing Slip Before Studies



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DEPARTMENT OF COMPUTER STUDIES

ROUTING SLIP BEFORE ERB

Name of Researcher(s) : **STEPHEN CHESTER V. BUENO, JEMMANUEL A. TALACAY, VLADIMIR, VALENZUELA**

Title of Study : **STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY – BACOOR CITY CAMPUS**

Type of Study :

○ Thesis ○ EDP ○ Field Study ○ Capstone Project Manuscript

	DATE RECEIVED	DATE RELEASED	REMARKS
DONNALYN B. MONTALLANA, MIT Capstone Project Adviser	2/5/25	2/5/25	revisions
	6/4/25	6/4/25	go for CapsA defense
EDMUND C. MARTINEZ Technical Critic	2/5/25	2/5/25	revision (please make)
	6/4/25	6/4/25	revisions
Department Chairperson			
Research Coordinator			

Appendix F. Gantt Chart

Republic of the Philippines
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DEPARTMENT OF COMPUTER STUDIES

GANTT CHART

Name of Researcher(s) : BUENO, STEPHEN CHESTER V.
TALACAY, JEMMANUEL A.
VALENZUELA, VLADIMIR

Program : BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

Title of Study : STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY – BACOOR CITY CAMPUS

ACTIVITY	2024		2025								
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Proposal drafting											
Proposal defense											
System design											
System development											
System testing											
System evaluation											
System implementation											
Manuscript preparation											
Final oral defense											
Manuscript review											

Appendix Table B. Gantt Chart

Appendix G. Budgetary Requirements

Republic of the Philippines
CAVITE STATE UNIVERSITY
Bacoor City Campus
SHIV, Molino VI, City of Bacoor
☎ (046) 476-5029
cvsubacoor@cvsu.edu.ph

DEPARTMENT OF COMPUTER STUDIES

BUDGETARY REQUIREMENTS

Name of Researcher(s) : **BUENO, STEPHEN CHESTER V.**
TALACAY, JEMMANUEL A.
VALENZUELA, VLADIMIR

Program : **BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY**

Title of Study : **STATIONERY GO: DEVELOPMENT OF A SCHOOL STATIONERY VENDING MACHINE FOR CAVITE STATE UNIVERSITY – BACOOR CITY CAMPUS**

PARTICULARS	AMOUNT (P)
1. Arduino Mega 2560	560.00
2. LCD2004A with IIC	175.00
3. Keyboard Keypad	100.00
4. DC Motor Gear	2,520.00
5. Vending Machine Spring	4,320.00
6. Infrared Sensor	240.00
7. Coin Hopper	2,600.00
8. Alpha Lock	305.00
9. Aluminum Frame	15,100.00
10. 12V 7A Power Supply	300.00
11. ESP32 WIFI Module	280.00
12. 12V 7A Rechargeable Battery	700.00
TOTAL	**₱27,200.00**

Appendix Table C. Budgetary Requirements

Appendix H. Request for Proposal Defense

Republic of the Philippines
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REQUEST FOR PROPOSAL DEFENSE

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Endorsed by:

DONNALYN B. MONTALLANA
Signature over Printed Name/Date
Adviser

EDMUND C. MARTINEZ/6/4/25
Signature over Printed Name/Date
Technical Critic

Recommended by:

Signature over Printed Name/Date
Department Chairperson

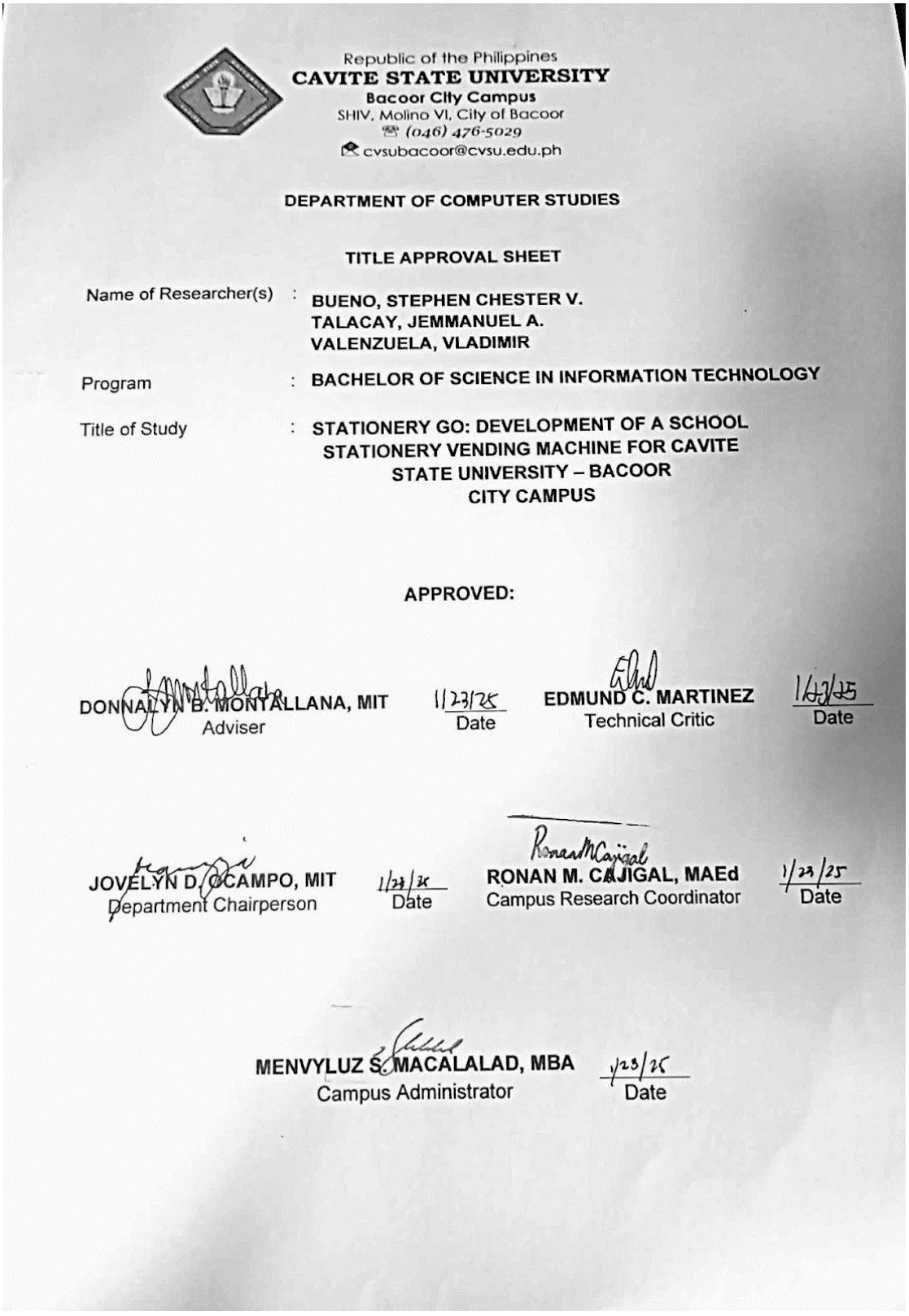
Signature over Printed Name/Date
Campus Research Coordinator

Approved:

Signature over Printed Name/Date
Campus Administrator

cc: capstone project instructor, adviser, technical critic, research coordinator, student

Appendix I. Title Approval Sheet



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DEPARTMENT OF COMPUTER STUDIES

TITLE APPROVAL SHEET

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APPROVED:

DONNALYN B. MONTALLANA, MIT — Adviser — 1/23/25 Date

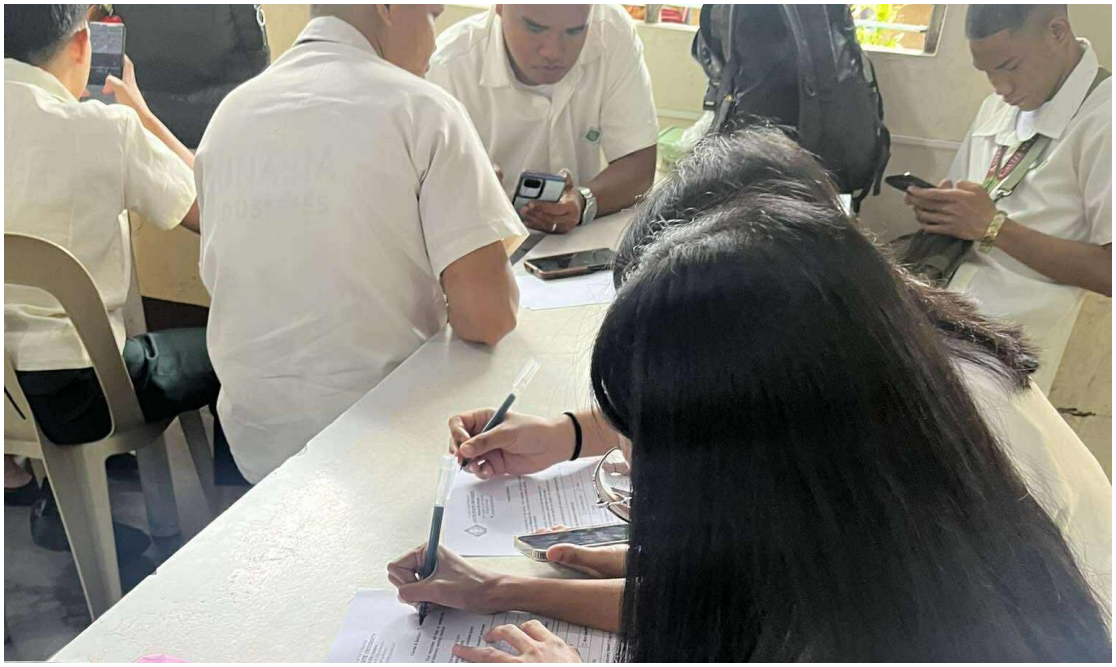
EDMUND C. MARTINEZ — Technical Critic — 1/23/25 Date

JOVELYN D. OCAMPO, MIT — Department Chairperson — 1/23/25 Date

RONAN M. CAJIGAL, MAEd — Campus Research Coordinator — 1/23/25 Date

MENVYLUZ S. MACALALAD, MBA — Campus Administrator — 1/23/25 Date

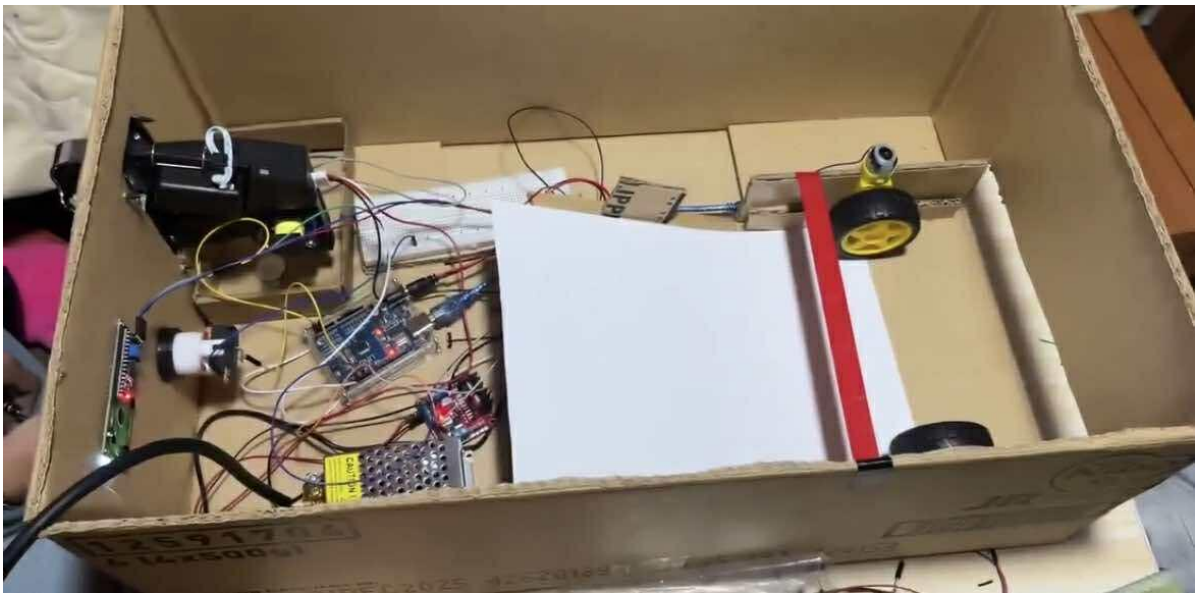
Appendix J. User Feedback



Appendix Figure 2. Survey conducted among Criminology, Information Technology, and Computer Science students regarding the proposed stationery vending machine.

Appendix Figure 3. Survey conducted among Education students and Psychology regarding the proposed stationery vending machine at Cavite State University, Bacoor.

Appendix K. Prototype Testing V1



Appendix Figure 4. Prototype testing of the vending machine Version 1 showing internal wiring and component layout.

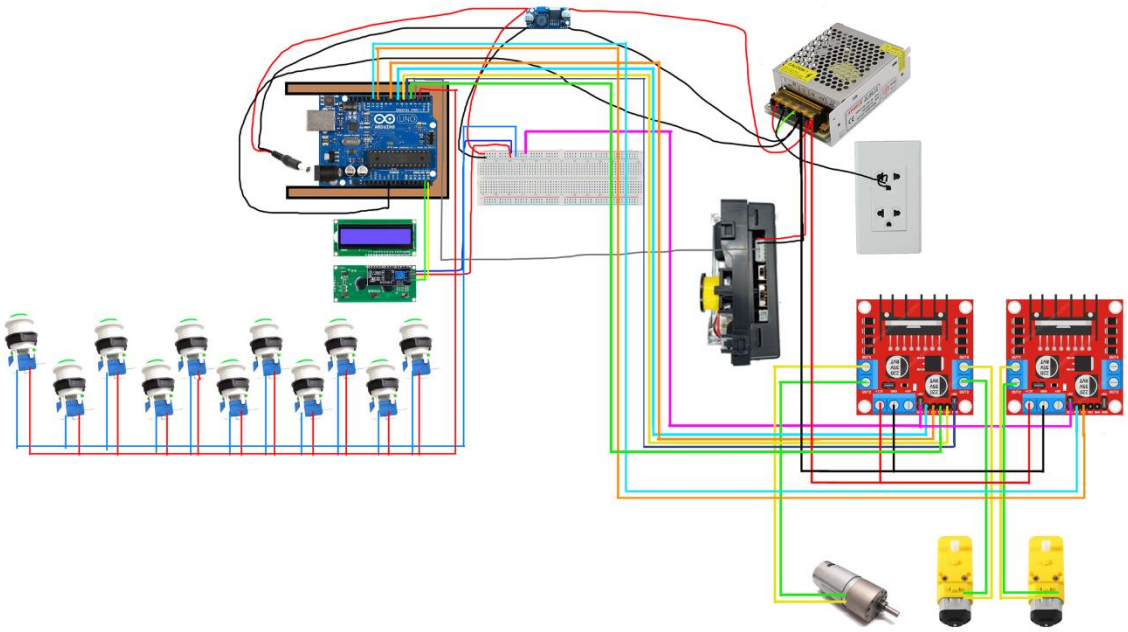
Appendix Figure 5. Prototype testing of the vending machine Version 1 showing the coin slot, LCD display, and control button interface.

Appendix L. Prototype Testing V2

Appendix Figure 6. Prototype testing of the vending machine Version 2 showing the external wooden structure, coin slot mechanism, and control buttons.

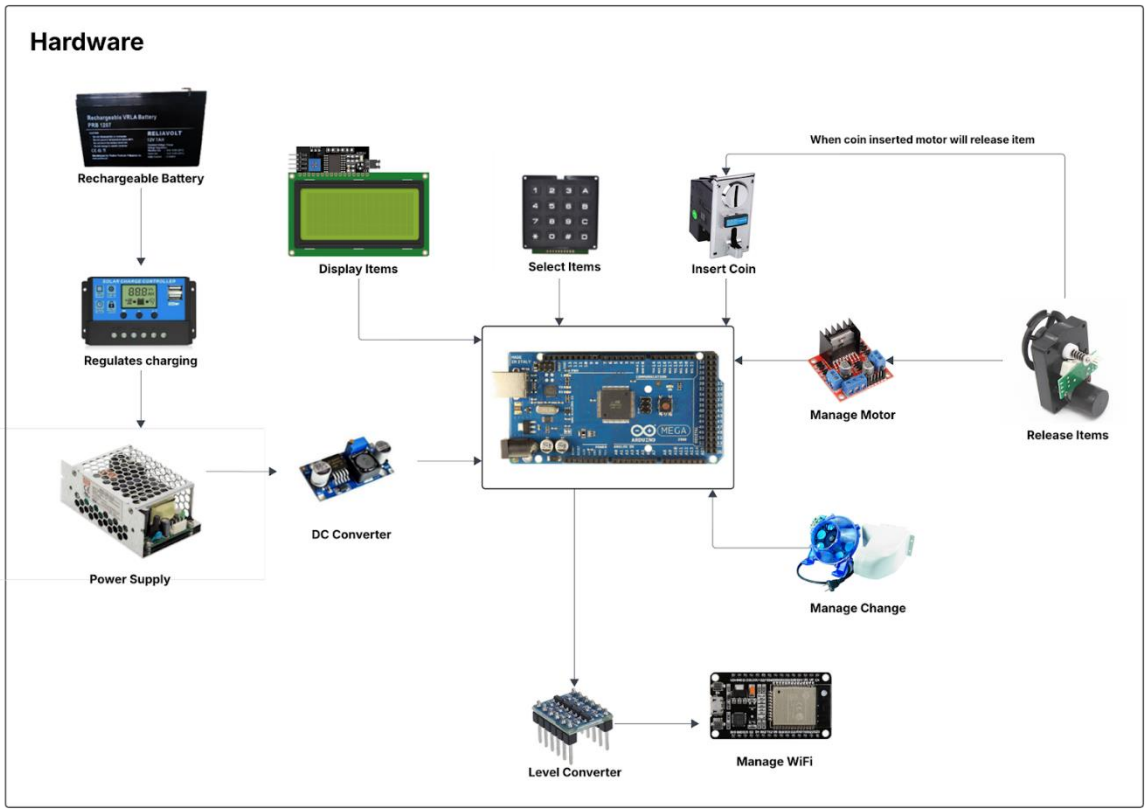
Appendix Figure 7. Internal view of the vending machine Version 2 showing the compartmentalized item slots and mechanical layout.

Appendix M. Arduino - Based Vending Machine System Circuit



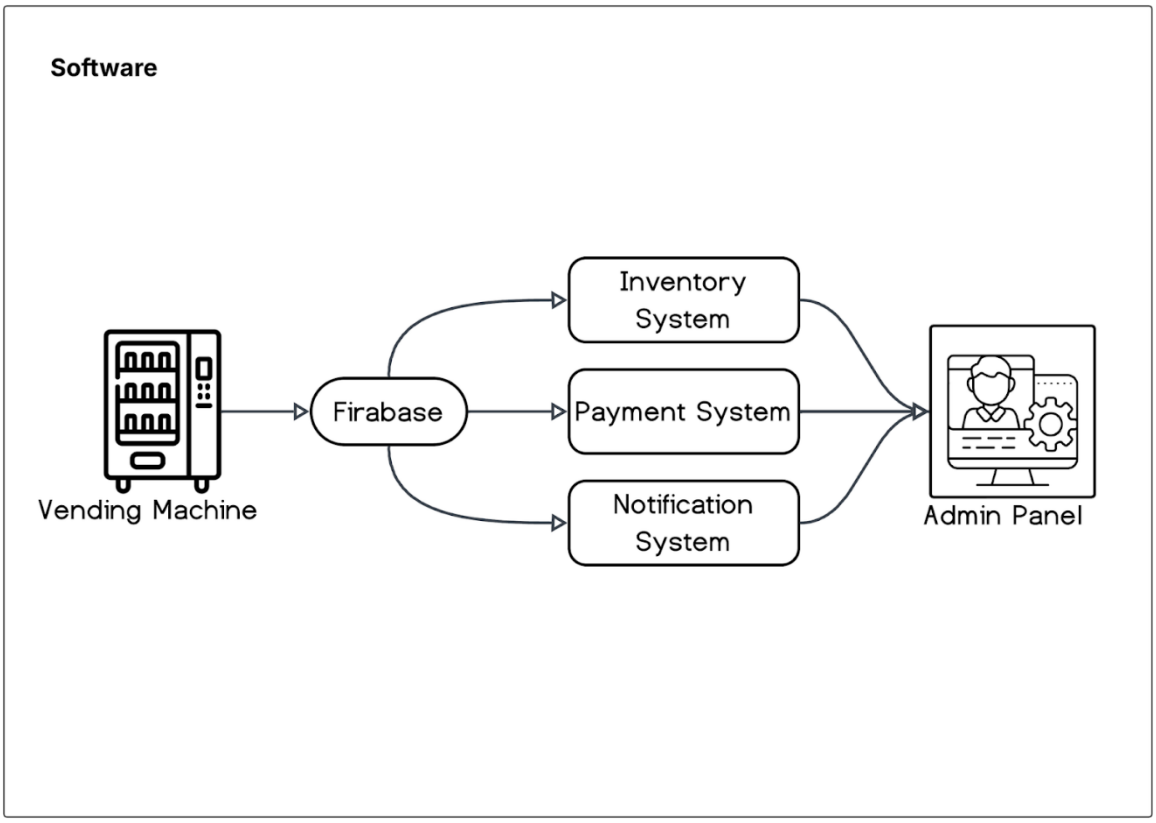
Appendix Figure 8. Arduino-based vending machine circuit showing connections among the microcontroller, coin slot module, power supply, push buttons, and motors.

Appendix N. Hardware System Architecture



Appendix Figure 9. Hardware system architecture of the Arduino-based vending machine, displaying the interconnection of components such as the power supply, display, microcontroller, sensors, and dispensing units.

Appendix O. Software System Architecture



Appendix Figure 10. Software system architecture of the vending machine showing the integration of Firebase with the vending machine interface, inventory, payment, and notification modules linked to the admin panel.

Appendix P. Report Analysis

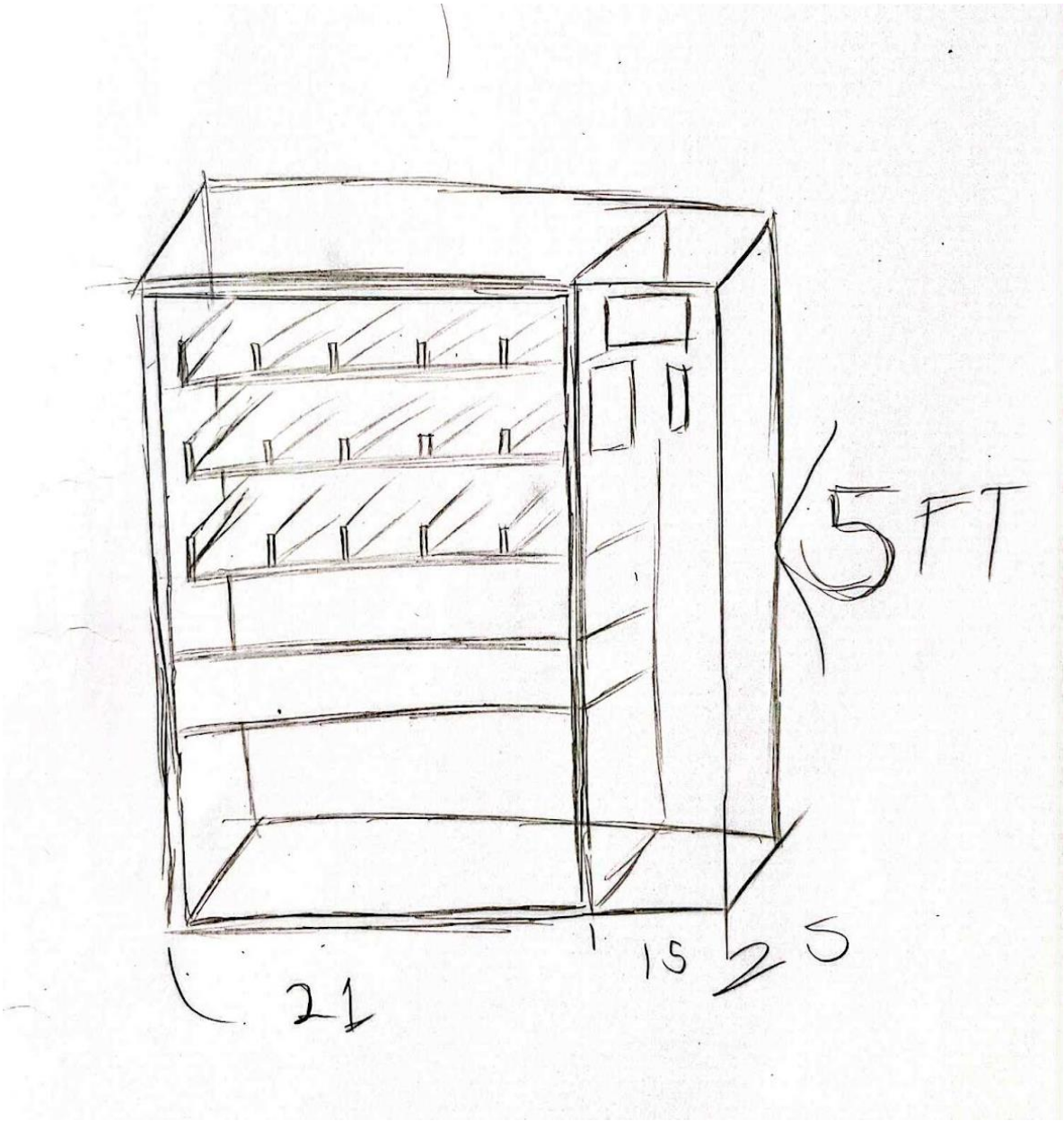
Analysis Report

To guarantee the project addressed real-world concerns, the proponents evaluated existing vending technologies, discovering common technical issues that influenced the system's improvement and innovation.

Issue Type	Observed Cases	Impact on Users	Proposed Solution
Coin validation errors	Frequent rejection of valid coins or acceptance of counterfeit coins.	Causes customer frustration and loss of trust in the machine.	Installed an accurate coin sensor
Product dispensing failure	Items getting stuck in the dispenser track.	Leads to failed transactions and user complaints.	Redesigned dispenser mechanism with smoother angles and stronger motors.
Maintenance downtime	Lack of automated system alerts for restocking or malfunctions.	Requires manual inspection, reducing operational efficiency.	Integrated IoT-based monitoring system for inventory and error reports.
Poor user interface	Unclear instructions and limited visual feedback.	Confuses users and prolongs transaction time.	Implemented LED indicators and simplified user instructions.
Security and tampering	Weak structural casing and outdated lock systems.	Risk of theft or damage to the machine.	Reinforced outer structure and added aluminum casing.

Appendix Table C. Report Analysis Case Summarizing common in existing vending machine technologies.

Appendix Q. Concept Sketch of Version 2 Vending Machine



Appendix Figure 12. Concept sketch of the Version 2 vending machine showing the overall structure, labeled dimensions, and shelving arrangement.

Appendix R. Fabricated Frame of Version 2 Vending Machine

Appendix Figure 13. Fabricated aluminum and glass frame of the Version 2 vending machine showing the assembled structure and designated compartments

Appendix S. Interior Layout of Version 2 Vending Machine

Appendix Figure 14. Interior layout of the Version 2 vending machine showing the organized shelving system and item dividers for product dispensing.

Appendix T. Exterior Layout of Version 2 Vending Machine

Appendix Figure 15. Exterior view of the Version 2 vending machine displaying the complete structure of front design and side design.

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