VENDO DITO, VENDO DOON: A WEB-ENABLED AND IOT- POWERED SMART VENDING MACHINE

A Capstone Project Presented to the Faculty of the

College of Computing and Multimedia Studies

Camarines Norte State College

Daet, Camarines Norte

In Partial Fulfillment of the Requirements

for the Degree of Bachelor of Science

in Information Technology

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2026

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ABSTRACT

Title:	Vendo Dito, Vendo Doon: A Web-Enabled and IoT- Powered Smart Vending Machine
Name of Institution:	College of Computing and Multimedia Studies Camarines Norte State College
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Authors:	Angcaya, Christian C. Bacuño, Abner Kenneth Y. Canoy, Jera Clarisse E.
Type of Document:	Undergraduate Capstone Project
Type of Publication:	Unpublished Capstone Project
Date Started:	January 2025
Date Completed:	November 2025
Keywords:	IoT, Vending Machine, Sari-Sari Store, Web Application

The study Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine addressed persistent operational issues in traditional sari-sari stores, particularly manual inventory tracking, limited monitoring capabilities, and inconsistent sales recording. By integrating Internet of Things (IoT) technologies with a web-based management dashboard, the system enabled automated product dispensing, real-time inventory updates, and accurate sales monitoring, allowing store owners to access stock levels and transaction data remotely.

The project adopted the Scrum Agile methodology, facilitating iterative development of both hardware components (sensors and microcontrollers) and software modules (web interface and data management system). System evaluation was conducted using the ISO/IEC 25010 software quality model, with feedback gathered from thirty (30) sari-sari store operators, including the primary client. Results demonstrated high ratings across all quality attributes, with an overall mean of 4.58 (Strongly Agree), indicating that the system is functionally complete, reliable, secure, user-friendly, and portable.

Notably, portability achieved the highest pooled weighted mean of 4.80, reflecting strong agreement on the system's ability to operate across platforms and be easily deployed devices. Overall, the findings highlight the effectiveness of IoT-based vending solutions in improving inventory accuracy, reducing manual workload, minimizing human error, and supporting scalable digital transformation for community-based micro-retail enterprises.

ACKNOWLEDGEMENT

The researchers offer their utmost thanks to the following people, whose unceasing support, advice, and inspiration enabled the present study to be completed:

Dr. Daniel E. Maligat Jr., as the Capstone Research and Project Instructor, for his unrelenting support, encouragement, and commitment to the proponents, his ardent leadership was critical in the successful achievement of this research;

Dr. Edgar Bryan B. Nicart, as the adviser of this study, for his patience, expertise, and unwavering support, his valuable insights and consistent guidance greatly shaped the direction and overall success of the project;

Instructor Bryan R. Arellano, and Instructor Spencer S. Saludes, as members of the panel, for their constructive feedback, meaningful suggestions, and devoted time that significantly enhanced the project's quality and development;

Mrs. Monina E. Canoy, as the client of this study, for her cooperation, and valuable time, which is critical in the development of the project;

To the Sari-Sari Store owners who willingly cooperated and welcomed the proponents to participate in the evaluation process for this research;

The researchers also extend their deepest gratitude

to their families—the Angcaya Family, Bacuño Family, and Canoy Family—for their unconditional love, constant encouragement, and steadfast support, their belief in the researchers' abilities served as a continuous source of motivation to continue this research;

Above all, the researchers offer their utmost gratitude to Almighty God, whose guidance, blessings, and grace sustained them throughout this journey.

The Researchers

DEDICATION

The proponents offer this work to their parents, whose unending support, understanding, and sacrifices—both emotional and financial—made it possible for them to pursue and accomplish this study. Their love and steadfast belief in the researchers' abilities served as a constant source of encouragement throughout the entire journey. They also extend this dedication to their instructors and advisers, whose guidance, patience, and invaluable mentorship helped shape the project and refine its direction. Their insights and wisdom were instrumental in overcoming challenges and ensuring the quality of the study. Sincere dedication is likewise offered to the client of this research, whose cooperation, knowledge, and openness greatly enriched the development of the system. Their contributions provided not only context but also purpose to this endeavor. Lastly, this work is devoted to every individual who, in ways big or small, contributed to the completion of this study. Their support, presence, and kindness made this achievement possible.

The Researchers

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Chapter 1

INTRODUCTION

Context of the Study

In today's rapidly evolving digital age, technology continues to influence and transform various aspects of daily life. Many industries are striving to adapt to emerging innovations to remain relevant and efficient. Among these innovations, the Internet of Things (IoT) stands out as a key enabler of digital transformation, offering new approaches to improve traditional systems and processes. As IoT-based devices become more widespread, their relevance continues to grow in sectors such as education, manufacturing, agriculture, and retail. According to Hercog et al (2023), the increasing number of IoT devices and the demand for IoT-related skills in the job market has led educational institutions to integrate IoT into their curricula. This reflects the broader societal shift toward smart, data-driven environments. One area witnessing significant IoT integration is automated vending machine systems, particularly in small- scale retail settings. Vending machines, once simple dispensers for snacks and beverages, have evolved into intelligent machines capable of conducting transactions independently, tracking sales, and managing inventory. Wiyanti and Alim (2020) highlighted the advancement of vending machine technology and its benefits to buyers, sellers, and

developers, especially in the age of smart business. These machines serve as convenient points of access for customers while offering business opportunities for operators. Sibanda et al. (2020) emphasized how vending machines increase accessibility to goods without the need for constant human supervision, while Jamme and Connor (2023) confirmed that a growing number of consumers prefer vending machines for their speed and ease of use.

Technological developments have resulted in a wide array of vending machine systems—both IoT-based and traditional—tailored to specific user needs and product types. These systems show how automation can streamline retail operations and enhance customer satisfaction.

In the Philippine context, sari-sari stores play a culturally and economically significant role. These small, often family-run shops are embedded within local communities and serve as accessible sources of basic goods. Historically, sari-sari stores have evolved from simple convenience stalls during the Spanish era to essential community hubs, especially during periods of hardship such as World War II (Flying Ketchup, 2024). Despite their continued relevance, sari-sari stores face enduring challenges, such as limited operating hours, manual inventory tracking, and constrained resources. Additionally, unstaffed vending models in the country are hindered by a broad range of customer preferences and

occasional service interruptions, as pointed out by Wang and Yao (2021).

Recognizing their value to local economies, especially Micro, Small, and Medium Enterprises (MSMEs), various institutions and private organizations have begun initiatives to digitize and support sari-sari stores. According to Nwosu and Umeh (2021), MSMEs are vital to the Philippines' inclusive economic development, and empowering them with modern tools can lead to broad socio-economic benefits. Ameen and Islam (2024) noted that IoT-powered vending machines, equipped with sensors and real-time monitoring capabilities, can offer sari-sari store owners' valuable insights into sales patterns and inventory levels. This, in turn, allows for smarter decision-making and enhanced profitability. Moreover, Enano (2024) cited how digital inventory systems are already helping Filipino entrepreneurs optimize their businesses. Organizations like Packworks, with the support of the Department of Science and Technology (DOST), are introducing AI-driven analytics to modernize sari-sari store operations (Reyes, 2024). Likewise, initiatives like BPI's BanKo e'Nay app are transforming local stores by providing access to digital finance and e-commerce platforms (Bunye, 2023).

Despite these advancements, many sari-sari store owners remain constrained by manual systems and limited access to affordable automation solutions. This reality,

coupled with the growing capabilities of IoT, presents a compelling opportunity for innovation.

Motivated by the intersection of tradition and growth of one of the Philippines' most iconic micro-retail models—the sari-sari store. The need to improve operational efficiency, extend service hours, and manage inventory more effectively, all while preserving the community-centric nature of these stores, served as the primary driver behind this study.

As a response, this research proposes the development of a web-based IoT-enabled vending platform specifically designed for sari-sari store integration. The proposed solution combines smart shelf systems with real-time inventory tracking, web access for remote monitoring, and anti-copy mechanisms to secure digital content related to inventory and sales logs. This hybrid model aims not to replace sari-sari storekeepers, but to augment their operations, enabling them to serve customers more effectively, reduce losses from stock mismanagement, and transition toward digital transformation—without compromising the cultural essence of community retailing.

By embedding IoT technology into a familiar and trusted retail format, the study seeks to contribute a practical, locally grounded solution that enhances both the livelihood of sari-sari store owners and the retail experience of the communities they serve.

Research Objectives

This study aims to develop and evaluate a web-enabled smart vending that is equipped with IoT-powered monitoring and management to address the operational challenges commonly faced by sari-sari store owners in their day-to-day lives.

1. Determine existing sari-sari store business operations to identify key requirements for the development of the proposed system;

2. Identify the information and system specifications that will be required to come up with a web-based IoT vending machine that is specific to sari- sari store operations;

3. Design and implement the features of the IoT vending machine system that will improve inventory control, sales tracking, and operational efficiency; and

4. Evaluate the system performance using ISO/IEC 25010 quality criteria along functional suitability, efficiency, reliability, usability, maintainability.

Research Questions

This research aims to design and develop a web-enabled smart vending that is equipped with IoT-powered monitoring, management, and analytics.

Specifically, this answered the following questions:

1. what are the current inventory and sales management practices used by sari-sari store operations;

2. what specific information and system requirements are necessary to develop a web-based IoT vending machine tailored to sari-sari store operations;

3. what features should be included in the IoT vending machine system to improve inventory control, sales tracking, and operational efficiency; and

4. what is the performance of the web-enabled smart vending that is equipped with IoT-powered monitoring, management, and analytics in terms of;

a. Functional suitability;

b. Performance efficiency;

c. Compatibility;

d. Usability;

e. Reliability;

f. Security;

g. Maintainability; and

h. portability?

Scope and Delimitations

This study focuses on the design, development, and evaluation of a web-based Internet of Things (IoT) vending machine system specifically tailored for sari-sari stores in the Philippines. The proposed platform aims to enhance traditional store operations by offering automated inventory monitoring, sales tracking, and real-time operational efficiency through wireless sensors, internet connectivity, and web-enabled digital control. The research

involves the development of a prototype system that integrates both hardware and software components to simulate the intended functionality. Key features include a user-friendly web interface for managing products, monitoring sales, and tracking inventory levels, as well as a backend system that enables real-time data logging, sensor integration, and remote access. The vending machine system is envisioned as a complementary solution to traditional store functions rather than a replacement, with the intent of supporting store owners in managing routine transactions more efficiently.

The scope of the study includes identifying and analyzing the operational workflows of selected sari-sari stores within specific localities to determine essential system requirements. These insights will guide the design and development of a scalable IoT vending system that incorporates intelligent dispensing, product tracking, and digital reporting. Additionally, the study involves selecting appropriate hardware and software specifications to implement the system, focusing on cost-effective and locally accessible technologies. Evaluation of the system is based on the ISO/IEC 25010 software quality standards, with emphasis on functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability.

However, the study is subject to certain limitations.

First, the scope of testing is limited to a small number of sari-sari stores in localized areas, which may not represent the full spectrum of operations across all mom-and-pop retail environments in the country. As such, while the findings are relevant, they may not be universally generalized. Second, the developed system is a working prototype intended for academic and simulation purposes. It Is not a full-scale commercial product and, therefore, has not been tested under commercial load, nor does it include features such as financial integration or customer authentication mechanisms that may be required in production-level vending systems. Third, the study does not delve into the external factors that may influence deployment in real-world settings, such as power outages, internet reliability in rural areas, or regulatory compliance regarding vending machine use and placement.

Moreover, the financial viability of implementing the proposed system, including cost-benefit analysis and return on investment, is beyond the scope of this research. The focus remains on assessing the technical performance and user experience of the prototype system, providing a foundational exploration of how IoT technology can support micro-retail operations in the Philippine context. These limitations are considered reasonable and feasible given the study’s academic nature, resource constraints, and time-bound implementation framework.

Significance of the Study

This research study can significantly benefit the following stakeholders in the retail practices space:

Sari-Sari Store Owners. Through the web-based IoT vending machine system, sari-sari store owners can now track their inventory levels and sales patterns in real time without any intervention. By continually monitoring, this will prevent stockouts and overstocking which would ultimately lead to lost sales and wastage. Automated transaction logging centralizes bookkeeping functions and produces easily actionable data related to the most popular items for sale, which allows owners to make informed decisions in bolstering their inventory. The unmanned vending module also extends service hours outside of the storekeepers present, realizing new revenue stream and improving the daily turnover.

Researchers and Developers of Technology. This paper offers a thorough framework for developing and accessing inexpensive IoT systems in micro-retail environments. It serves as a reference model for upcoming smart-retail initiatives by outlining the system requirements, architectural elements, and user-centered interface. A reproducible framework for evaluating comparable solutions is provided using ISO/IEC software quality criteria, such as functional suitability, performance efficiency, compatibility, usability, reliability, security,

maintainability and portability.

Academic Community. This research provides a tangible, regionally relevant case study that connects theory and practice as educational institutions work to include IoT competences into their curricula. It enhances business, engineering, and information systems courses by providing a thorough illustration of how IoT is used in micro-retail. The limits that have been highlighted, such hardware limitations and the requirement for thorough cost- benefit analysis, also indicate promising directions for future study, such as large-scale deployment evaluations, ROI modeling, and AI-driven demand forecasting.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter offers a thorough analysis of connected material gathered from a variety of sources and backgrounds that are pertinent to or supportive of the ongoing inquiry. This comprises all pertinent statements, publications, and citations. And relevant research carried out by different authorities pertinent to the focus of the research issue.

Existing sari-sari store operations

Sari-sari stores overwhelmingly rely on handwritten ledgers and manual stock takes—methods shown to introduce inventory discrepancies of 15–20 percent when compared to actual on-hand quantities. These inaccuracies create a cascade of operational issues: delayed reorder cycles, unexpected stockouts, and ultimately, lost sales and eroded customer trust. MJ B. (2024) reports that such stockouts are “frequently caused by inaccurate inventory counts and inadequate inventory management,” leading to missed revenue opportunities and diminished service levels.

According to Kitti systems and small and medium enterprises (SMEs) have adopted various strategies to improve their inventory management practices, including outsourcing inventory functions, implementing technology-driven monitoring systems, and developing lean supply chains. The study emphasizes the critical role of efficient inventory control in the success of SMEs, particularly in

the cosmetics industry and provides valuable insights for practitioners seeking to optimize their inventory systems.

Compounding this, Pasaribu (2021) notes that traditional, paper-based systems lack real-time visibility, making it difficult for store owners to make timely decisions on restocking and pricing, further hampering their ability to respond dynamically to consumer demand.

More so, a study of micro-retail businesses in the Philippines by Santos and Dizon (2023) points out that sari-sari stores tend to be run without much technological support and run their operations more on experience-based decisions than on data-driven ones. They observe that inventory wastes through spoilage, expiration, and untold stock losses are usual since the owners do not have systematic processes of sales monitoring and real-time tracking.

Information/System Requirements for IoT Vending Machine Development

As Suhaimi Yusof et al. (2025) noted, vending machines in the fast-evolving environment of automated retail are gaining in number, and their range of products has dramatically broadened as they now provide items beyond snacks and drinks. This systematic review covers historical development, trends, innovations, and consumerism in the context of vending machines. Advances in IoT-enabled

vending solutions demonstrate how networked sensors and embedded controllers can transform manual retail processes. Tegeltija et al. (2020) outlines a universal IoT vending-machine management platform that integrates new control units—combining legacy hardware with modern firmware—to enable features such as remote stock auditing, dynamic price adjustments, and predictive restocking alerts. Similarly, Wiyanti and Alim (2020) show that embedding microcontrollers and sensor arrays into traditional vending machines allows continuous monitoring of inventory levels and machine status, which can drastically reduce human intervention and prevent unplanned service interruptions.

According to RAJU and HUDA, 2023 Sales Monitoring System for Vending Machine using IoT improves the operations of the vending machine by giving the owners a full view of the beverage inventory and sales data. IoT technology and Google Sheets enable a more efficient and profitable decision-making process as the owners can make data-driven decisions.

Moreover, Aguilar and Perez (2024) mention that IoT vending machines which are designed to operate in low-resource settings should feature modular sensor integration, offline-compatible firmware, mobile-first dashboards, and lightweight server-side APIs. These features collectively ensure reliable operation, ease of maintenance, and scalability even in environments with

limited connectivity and infrastructure.

IoT Vending System Features for Inventory, Sales Tracking, and Efficiency

Mohamed Nor Hashi et al. (2023) argues that a strong cloud computing framework is developed through the cooperation between sensors and actuators. Such a framework can be applied in developing object networks in real-time systems that are autonomous. The Internet of Things (IoT) is making an important contribution in redefining other meaningful concepts, such as urbanism and smart cities. Since IoT-enabled smart city systems are relatively new, their underlying technologies can be leveraged to enhance the efficiency and quality of life for users in other domains, including retail automation.

To adapt IoT vending technology to the sari-sari context—characterized by limited shop floor space, intermittent power, and basic internet access, the system must employ low-cost, low-power sensors (e.g., weight and infrared detector) managed by edge-capable microcontrollers like the ESP32. Wiyanti and Alim (2020) emphasize the need for offline-first architectures with local data buffering during network outages, coupled with secure digital payment integration for seamless transactions. Hercog et al. (2023) further recommend leveraging educational-grade IoT device designs to ensure robustness and ease of use for non-technical operators.

Moreover, Islam Ameen (2024) highlights that a lightweight, mobile-friendly web dashboard is essential for real-time sales and inventory tracking on basic smartphones, enabling store owners to make informed decisions on-the-go. Vending machines based on IoT are progressively adding machine learning, cloud analytics, and remote device management to their capabilities to improve efficiency. Lee and Ramos (2024) indicate that modern IoT vending systems are advantageous because they have predictive algorithms that predict which items will be depleted earlier so that they can be replenished in advance. This minimizes time loss and enhances customer satisfaction. On the same note, Garcia et al. (2023) state that it is important to have a cloud integrated system of notifying the operators about low-stock products, anomalies in sales, and sensor failures in real-time. These innovations reveal the increasing trend towards massively automated and controlled remotely vending ecosystems that directly satisfy the demands of sari-sari store owners who frequently must multitask and need monitoring devices that can be operated manually.

Evaluation of Metrics and Criteria for the Implemented System

The evaluation framework was systematic and determined the quality of the implemented system of web-based IoT vending in compliance with the ISO /IEC standard 25010.

Instead of making a technical performance logs evaluation, the analysis put more importance on the user perception based on a questionnaire of five-point Likert scale questionnaire to thirty (30) sari-sari store operators. All the ISO/IEC 25010 quality characteristics, such as functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability, were represented in survey indicators rated by the respondents since the actual experience with the system.

The concerns of usability evaluation in interactive systems were studied using a Likert-scale survey by Maqbool (2024) to evaluate the perceptions of the user towards the effectiveness and efficiency as two of the essential elements of software quality. Their research shows that the use of perception-based metrics can produce credible results on the usability of a system without the need to involve complex technical performance results. This is directly in line with the current study and applies a five-point Likert scale in measuring the perception of the usability, efficiency, and general acceptability of the IoT based vending and inventory management system to the sari-sari store operators.

Moreover, Maqbool (2024) focuses on the significance of systematic assessment criteria that are in line with the established quality principles. This is in line with the

fact that the ISO/IEC 25010 quality model utilized in the current study has the same dimensions as performance efficiency, usability, reliability, and functional suitability which are assessed based on user feedback. The consistency in methodology between the approach of Maqbool and the current study enhances the validity of the use of a perception-based Likert scale to determine the quality of the system. It shows that user-experience data are still critical in defining the strengths and weakness of a system implemented, particularly when implemented in real-life settings such as the sari-sari stores.

To assess the effectiveness of smart government systems, Purbaratri et al. (2023) suggested to revise an existing software quality model by using ISO/IEC 25010 and focus on formal and quantifiable quality indicators to define the level of system utility. In their work, it is emphasized that ISO / IEC 25010 is very flexible and can be used in different fields of government systems, the provision of services to the population, and new smart technologies. This goes hand in hand with the current research, which uses the same Quality characteristics of the ISO/IEC 25010 to evaluate the IoT-based vending and inventory control system of the sari-sari stores.

The functional suitability was tested using questions that determined the precision of the system in recording sales and monitoring inventory. Efficiency in the

performance was evaluated by rating of responsiveness, loading time and system smoothness by the users. The usability (easy navigation and legibility of interface) was assessed wholly on perceived effectiveness in terms of Likert-scale answers. Maintainability and reliability were also reflected in the user perceptions of system stability, system errors, ease of updating the system, and ease of troubleshooting.

As pointed out by Jean Baptiste Minani et al. (2024), the evaluation of the IoT systems must consider the traditional qualities of software quality, as well as be dynamic in terms of connection and interaction between the devices. By integrating these, the Likert-scale items in this study aimed at describing the conception of users regarding the stability, responsiveness, and consistency of the system in the actual operating conditions. Khanna and Kaur (2020), in turn, also emphasize the significance of considering security and privacy issues during the assessment of IoT; after that, the user ratings were added to the data protection, login security, and general trust in the system.

The study employed Likert-scale as the means of primary evaluation to obtain both quantitative and qualitative data regarding user satisfaction and information about system experience. This strategy allowed gaining a comprehensive perspective on the efficiency of

the IoT vending system according to the ISO/IEC 25010 quality features relying on the impressions of real sari-sari store operators.

Synthesis of the Art

The vast literature casts a dim view on how IoT-based vending solutions can be tailored to suit the sari-sari store setting:

First, background literature on traditional retail systems discusses deeply seated issues of inventories. According to Secretario and Naval (2021), micro and small grocery outlets have inventory practices closely tied to their business life; yet they often operate without real-time stock visibility, thus accruing discrepancies that evoke stockouts and lost sales.

Nicole (2018) accentuates the entrepreneurial mindset of sari-sari operators but mentions that without computerized tracking, these stores find it difficult to scale up profitably. Enhancing an expansive number of vending machines offering new technologies proves a direct model of futuristic technologies. Sibanda et al. (2020) describe a "high-tech vending machine" set to dispense different products securely and autonomously using fingerprint sensors, IR detectors, and clouds to demonstrate how the augmented sensor array could be used for stock-level maintenance and increased user trust. Maulana et al. further illustrates that QR-code payment via

the Android app not only contributes to ease in the transaction but also integrates user-account management within the flow of vending, thus reducing cash handling risk and creating better sales data collection.

Apart from hardware, system-level innovations are very important. Kurdi et al. (2022) empirically show that blockchain-backed smart inventory systems improve supply chain performance by ensuring data immutability and automating reorder triggers-capabilities that could decrease the reorder delays to which sari-sari stores are so susceptible. In another example, Xia et al. (2021) envisage an intelligent self-service vending system that leverages Alibaba Cloud IoT and a merchant-oriented web interface for working remote device monitoring and historical sales analysis features that are so critical for owners lacking site technical capabilities.

Finally, usability and accessibility research allows these technologies to be extended to a wider range of users. Caporusso et al. (2020) analyze the user experience of automated vending machines when it comes to product selection, payment, and collection phases and, in these parts, pinpoints the significance of intuitive interfaces and clear feedback loops for non-technical users. In a similar context, Ni et al. (2022) argue that mobile-based customer management systems designed for supermarkets can also be adapted for micro retail, which allows real-time

sales tracking and customer profiling through lightweight smartphone applications.

It should be noted that all these strands of research together indicate that a well-functioning web-based IoT vending solution for sari-sari stores would be one that provides reliable hardware for sensing and payments combined with blockchain-empowered inventory logic, cloud-native monitoring dashboards, as well as friendly user interface designs that all fit the scarce resources and informal workings of neighborhood retail.

Studies suggest that successful web-based IoT vending solutions for sari-sari stores require reliable sensing, cloud-native monitoring dashboards, and simple, user-friendly interfaces suited to resource-constrained, informal retail workflows.

Chapter 3

RESEARCH METHODOLOGY

This chapter outlines the systematic approach undertaken to guide the research from inception to evaluation. It begins by describing the selection of participants and profiling of research sites, followed by an overview of the data collection methods employed—such as semi-structured interviews, stakeholder workshops, and system-generated logs—to gather requirements and assess performance. The chapter also details the adopted software development life cycle, including the edge computing architecture, sensor integration strategies, and iterative testing procedures. Finally, it presents the analytical methods used to interpret both quantitative and qualitative data, including statistical accuracy measures, usability surveys, and focus group discussions, along with the activity timeline and system workflow. These components collectively establish the methodological rigor that underpins the study.

Software Development Methodology

The development of Vendo Dito, Vendo Doon was aligned with the Scrum methodology in Figure 1, where work progressed through iterative sprints that transformed project scope into usable software and hardware increments. At the Scope stage (January–February), the team formation, topic proposal, consultant allocation, and initial

consultations with sari-sari store owners defined the project vision and objectives. These activities established the real-world operational problems to be addressed and served as the foundation for backlog creation, ensuring that subsequent sprints were closely aligned with actual sari-sari store operational needs.

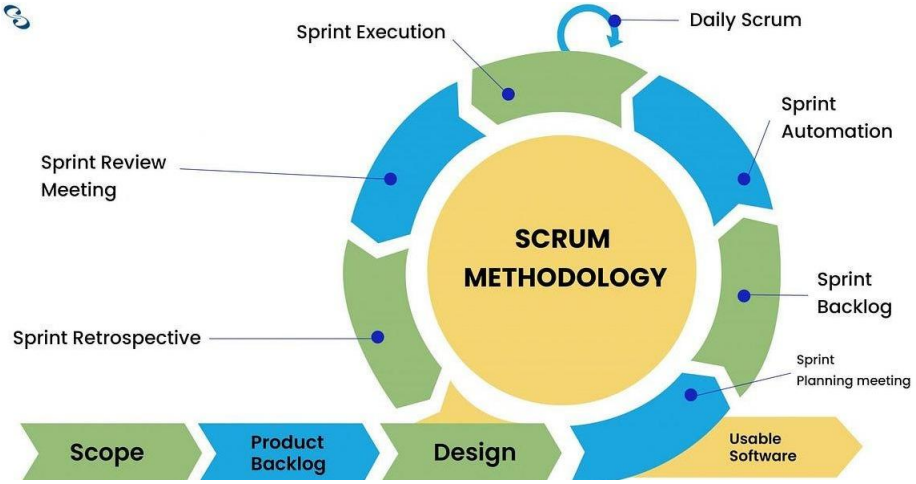

Figure 1. Agile Scrum Methodology

The Product Backlog phase (February–March) involved gathering and refining system requirements through follow-up consultations with stakeholders. Key functionalities of the IoT-based vending system were identified, including sensor monitoring, inventory tracking, and a web-based dashboard. In parallel, academic deliverables such as the introduction, problem statement, related literature review, and initial system layout were completed. Technical research on suitable microcontrollers, IoT technologies, and web frameworks also contributed to prioritizing backlog items. This comprehensive preparation ensured that the development team had a clear roadmap and a finalized the technical architecture before beginning the implementation

phase, reducing development risks and improving sprint efficiency.

During Sprint Planning Meetings, backlog items were selected and organized into three major sprints. Design-related tasks were emphasized in early planning, including database schema design, system architecture, and user interface prototyping. These planning activities guided sprint execution and ensured that development tasks were feasible within each sprint cycle.

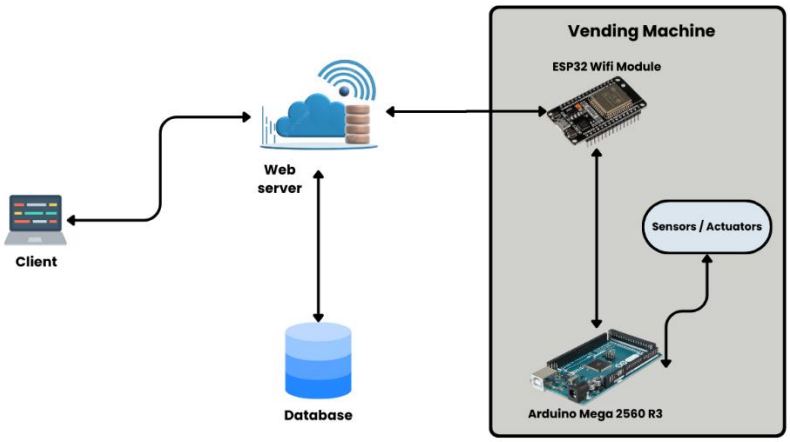

Figure 2. System Architecture

As part of the design and development activities defined during Sprint Planning and Sprint Execution, the system architecture of Vendo Dito, Vendo Doon was incrementally designed and implemented, as shown in Figure 2. The web server serves as the central component, communicating with the database to store and retrieve inventory, sales, machine, and sensor data. On the device side, an ESP32 WiFi module enables real-time communication between the vending machine and the server, transmitting data and receiving control commands.

The ESP32 relays these commands to the Arduino Mega 2560 R3, which directly interfaces with sensors and actuators responsible for monitoring inventory levels and dispensing products. Sensor readings and machine status updates are continuously sent back to the server and reflected on the client-facing web interface. This architecture demonstrates the integration of cloud services, IoT hardware, and a centralized web application, supporting real-time monitoring, automation, and efficient inventory management for sari-sari store operations. The architecture was refined iteratively across sprints based on testing results and stakeholder feedback, consistent with the Scrum methodology.

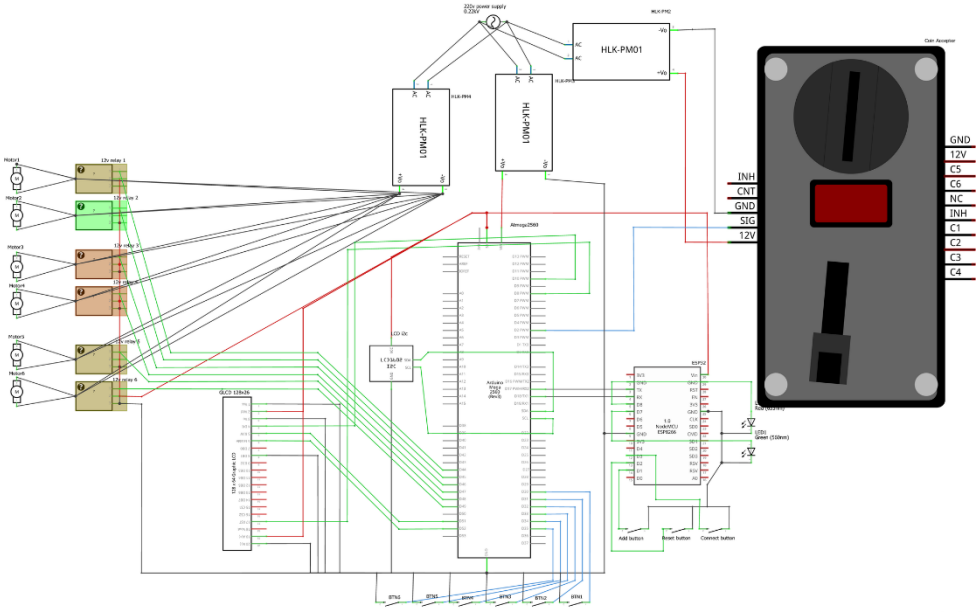

Figure 3. Schematic Diagram

To support the system architecture shown in Figure 2, the vending machine's schematic diagram in Figure 3 was designed using an Arduino ATmega and an ESP32 WiFi module working in tandem. The Arduino ATmega functions as main

hardware controller, managing coin detection, motor actuation, LCD displays, and compartment selection buttons. The ESP32 is responsible for wireless communication and WiFi configuration, enabling real-time data exchange with the web server. This separation ensures stable hardware control and reliable real-time connectivity.

Serial communication between the ESP32 and Arduino allows control commands and system status data to be exchanged efficiently. Status LEDs provide visual feedback for system states, while a 12V coin acceptor supplies pulse signals for accurate payment detection. Each vending compartment is equipped with a microswitch and a 12V geared DC motor, controlled through relay modules to ensure reliable product dispensing.

User feedback and system information are displayed using an I2C LCD connected to the Arduino. Power is distributed through a regulated 12V supply with shared grounding to maintain system stability. This hardware configuration ensures seamless integration between the IoT module, control logic, and mechanical components, supporting reliable vending operations.

The Sprint Execution phase occurred from April to September and covered the core development activities. In Sprint 1 (April–June), the team set up the development environment, designed the database, developed initial web modules, and tested microcontroller components. Sprint 2

(June–August) focused on coding individual hardware components, integrating sensors with the web dashboard, improving device connectivity, and designing the casing. Sprint 3 (September) emphasized system integration, optimization of the web interface, and preparation for deployment. Throughout these sprints, daily Scrum practices supported coordination, issue tracking, and continuous progress.

Sprint Review Meetings were conducted regularly, particularly during stakeholder consultations and user testing sessions. Feedback from sari-sari store owners was used to validate features, assess usability, and ensure that the system addressed real operational needs. In November, formal system evaluation and user testing served as a comprehensive sprint review, confirming functionality and identifying areas for refinement.

Sprint Retrospectives were implicitly carried out through continuous testing, integration, and reflection on technical challenges encountered in both firmware and software development. Lessons learned from earlier sprints informed improvements in later stages, such as performance optimization, hardware stability, and interface usability.

The Scrum cycle culminated in Usable Software and Hardware outputs. By October, system installation and near-complete integration were achieved, while December focused on final optimization, documentation, and deployment

readiness. Through Scrum's iterative and feedback-driven process, the project achieved flexibility, transparency, and user-centered design, resulting in a reliable and practical IoT-based smart vending solution tailored for sari-sari stores. This approach also enabled the team to quickly address issues and implement improvements at each sprint, ensuring a high-quality final product.

Schedule of Activities

Vendo Dito, Vendo Doon development was informed by a methodology based on the ideas of Agile that focused on the idea of iterative building, stakeholder involvement, and the focus on improvement.

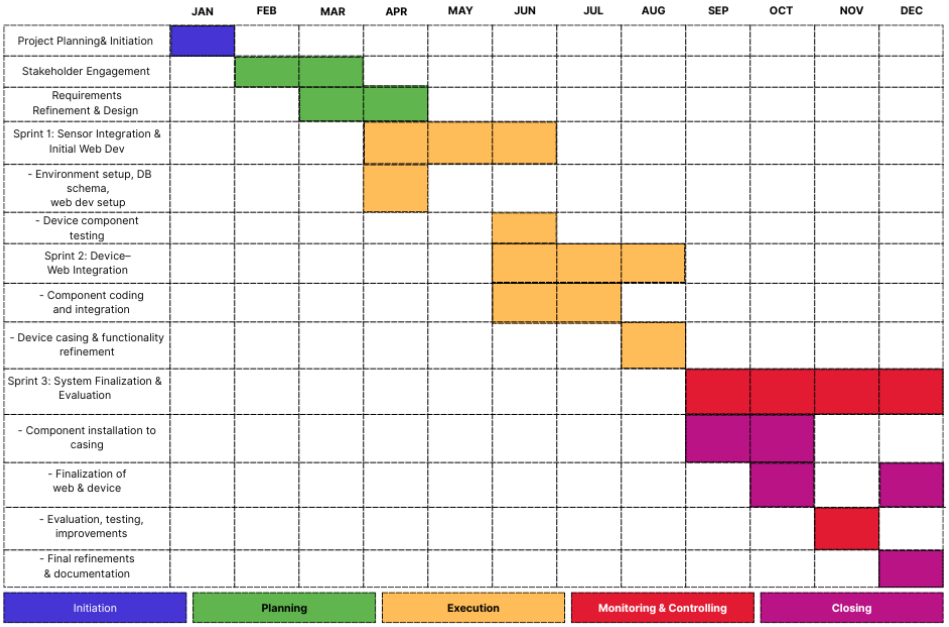

Figure 4. Timeline of Activities

The plan of activities illustrated in Figure 4 was organized in three large sprints, which lasted about two to three months. This sprint process guaranteed that the device and the web application got built in a gradual

manner, tested and perfected against client and user reports.

This task was carried out in January, as indicated by the bar under that month. During this period, the project team was formally organized and roles were assigned. The research topic Vendo Dito, Vendo Doon was proposed and defined, including the initial scope, objectives, and intended outcomes of the system. This stage laid the groundwork for both the technical and academic components of the project.

Stakeholder engagement activities took place in February and March. These included proposal acceptance and consultations with the project adviser and potential clients. Early discussions with sari-sari store owners were also initiated to understand operational challenges and expectations. This phase ensured that the project direction was aligned with stakeholder needs before detailed design and development began.

The Requirements Refinement and Design phase occurred across March and April. Activities included reviewing related literature, refining system requirements, defining system architecture, and creating initial layouts for the user interface and user experience (UI/UX). The functional and non-functional requirements established in this phase guided subsequent sprint planning and development tasks.

Sprint 1, conducted from April to June, focused on

sensor integration and initial web development. In April, the team prepared the development environment by setting up the necessary tools, defining the database schema, and establishing the initial structure of the web application, which provided a stable foundation for backend and frontend development. In May, individual hardware components, particularly microcontroller-based sensors, were tested to verify their functionality and compatibility, ensuring that the selected devices could support the required system features prior to full integration.

Building on this, Sprint 2, which spanned June to August, emphasized device–web integration. During June and July, firmware was developed and hardware components were coded and integrated with the web-based dashboard, allowing validation of data transmission, sensor readings, and basic control functions. In August, efforts shifted toward refining the physical casing of the device and improving overall functionality, addressing durability, usability, connectivity, and performance issues identified during earlier testing.

The final phase, Sprint 3, took place from September to December and centered on system finalization and evaluation. From September to October, all tested components were installed into the finalized casing and verified for stable real-world operation. In November and December, the web application and hardware device were

further refined to improve interface usability, system responsiveness, and communication reliability. System evaluation and user testing were primarily conducted in November through feedback sessions with sari-sari store owners, which informed targeted improvements. The project concluded in December with final refinements and comprehensive documentation, ensuring that the system was stable, deployment-ready, and met both technical and academic requirements.

Overall, the Figure illustrates a chronological, sprint-based execution of the project. Early months focused on planning, stakeholder alignment, and design, while later months emphasized development, integration, testing, and refinement. The timeline reflects the iterative nature of Scrum, where each task built upon the outcomes of previous activities and was continuously improved.

Sources of Data

These primary data for the study were collected directly from sari-sari store operators using two adjunct instruments. The first was a semi-structured interview between the owners of Vendo Dito and Vendo Doon, giving in-depth information on their inventory control practices, decision-making processes, and unmet needs. These interviewed conversations allow in-depth probing into nuances in workflow and technology literacy. The second primary tool is the structured questionnaire discussed

among a wider sample of sari-sari operators for the purpose of quantifying the prevalence of specific challenges such as the frequency of stock-outs or manual tracking errors. Further, it gauges priority share preferences for an IoT vending solution.

The secondary data was taken from a comprehensive review of literature on small-scale retail management and IoT-based vending technologies. Empirical studies such as those conducted by Secretario and Naval (2021) illustrate how discrepancies in inventories at micro-retail could be as high as 15-20% and indicate how much manual tracking is incorrect. Nicole (2020) revealed the entrepreneurial dynamics of sari-sari operators while identifying the limitations of non-computerized systems. The search considers other works on IoT vending platforms, for example, Tegeltija et al. (2020), which described sensor-based stock auditing and predictive restocking alerts, and Sibanda et al. (2020), who also demonstrated advanced sensors and cloud connectivity integrated into high-tech vending machines. These studies provided the empirical and technical basis for the design of the proposed system, particularly in addressing inventory inaccuracies and the need for real-time monitoring These insights bridge the gap between manual inventory challenges and modern automated solutions. Lastly, the reviewed literature highlights the growing relevance of integrating IoT solutions.

Population of the Study

The research completed by this approach utilized the purposive sampling technique that is the type of non-probability sampling and allows to gather the specific information on a specific event because the sample chosen is the most relevant to the objectives of the study (McCombes, 2023). To determine how useful the IoT device was to professionals and students, the proponents concluded that the study is made of thirty (30) sari-sari store owners with the main client serves as the subject of the research.

Data Collection Method

This study was collected in both qualitative and quantitative format to collect as much information as possible about the requirements of the sari-sari stores operators and to test the developed system of IoT-based vending and inventory management. To learn about the current inventory process, general challenges faced by the owners of Sari-sari stores, as well as what an automated solution would provide them, semi-structured interviews with them were held. These interviews were used to establish the features the system needed to have.

A questionnaire was used to gather and get quantifiable variables of user perception by administering a structured questionnaire to thirty (30) sari-sari store operators which included the main client. The survey tool was a five-point Likert scale that was able to measure

important aspects of the system against the ISO/IEC 25010 quality characteristics. The questionnaire was used to record their evaluations of the system by the users on its functional suitability, performance efficiency, usability, reliability, security, maintainability, compatibility, and portability. The evaluated tables were calculated using the obtained responses, which were weighted. Such a mixture of the interviews and the responses to the survey allowed getting the full picture of the needs of the users and their assessment of the system applied. For secondary data, a systematic literature review was performed on studies related to small-scale retail and IoT vending systems—drawing on empirical findings such as the 15–20 percent inventory discrepancies documented by Secretario and Naval (2021) and the sensor-based auditing frameworks described by Tegeltija et al. (2020) and Sibanda et al. (2020). This combination of field-collected and published data ensured a comprehensive understanding of both user needs and established technological solutions.

Data Analysis

Overall, this triangulated approach enhanced the validity of the findings by aligning user feedback with documented industry practices and proven IoT-based solutions.

Analysis of the data collected in the survey was done on quantitative basis, that is, computation of weighted

means to assess the user perceptions concerning the implemented system. All the survey items were based on one of the quality characteristics of ISO/IEC 25010 and assessed the degree of agreement of the respondents with the use of the five-point Likert scale. Table 1 has calculated the weighted mean of each indicator and interpreted the result per the scale. his approach provided an objective measure of the system's overall quality and user acceptance.

Table 1. Likert Scale

Scale	Interval	Verbal Interpretation
5	4.21 – 5.00	Strongly Agree
4	3.41 – 4.20	Agree
3	2.61 – 3.40	Neutral
2	1.81 – 2.60	Disagree
1	1.00 – 1.80	Strongly Disagree

The interpretation of the quantitative results was supported by qualitative data collected through interviews, where they determined the prevalence of feelings, difficulties in operation, and expectation of users when it comes to inventory management and sales management. These themes authenticated the content of the survey items and put the results into perspective.

The analysis established the general acceptability of

the system by the functional suitability, performance efficiency, usability, reliability, maintainability, security, portability, and compatibility of the overall system. The findings informed the determination of the areas where the system was successfully addressing the needs of the users and areas of improvement.

Statistical Treatment of Data

The statistical analysis of the data obtained was aimed at summarizing the user ratings of the introduced IoT-based vending and inventory management system using descriptive statistical techniques. The analysis primarily employed the weighted mean to determine the overall perception of the thirty (30) respondents with respect to each of the ISO/IEC 25010 quality characteristics, including functional suitability, performance efficiency, usability, reliability, security, maintainability, compatibility, and portability.

The frequency of responses to each item on the scale (1-5) was multiplied by a weight of each scale. The figure presented below was calculated using the formula:

$$\bar{x} = \frac{\sum(wx)}{N}$$

here:

f= frequency of each Likert response

w= numerical weight of the response

N= total number of respondents

Means that resulted were then interpreted using the verbal interpretation scale included in Table 2. This enabled the researchers to establish the general degree of consent of the users on the quality attributes of the system. There were no complex inferential statistical manipulations, the main intention of the assessment was to assess user satisfaction and system perceived effectiveness. In this way, the weighted mean method was the only method used and adequate as the statistical method to determine the performance of the system regarding ISO/IEC 25010 benchmarks.

Ethical Consideration

This study strictly adhered to ethical standards to ensure the protection, dignity, and voluntary participation of all individuals involved. Before any data collection commenced, the research underwent review and approval from the institution's Research Ethics Committee to verify its compliance with academic and legal ethical guidelines. All participants—primarily sari-sari store owners from Vendo Dito, Vendo Doon, and other selected sites—were provided with a clear explanation of the study's objectives, procedures, potential risks and benefits, and the expected duration of their involvement. Informed consent was obtained through signed consent forms, and participants were informed of their right to refuse to answer specific questions or to withdraw from the study at any point without

any adverse consequences. The research process was designed to ensure that no harm—whether physical, emotional, or reputation would come to any participant, and questions posed during interviews and surveys were respectful, non-invasive, and culturally sensitive. To maintain data privacy and confidentiality, all personal and business-related information gathered was treated with the highest level of discretion. Identifiable information such as names, store addresses, and contact numbers was anonymized or omitted in all documentation, including interview transcripts, survey results, and system usage data. Digital files were securely stored using password-protected systems, and access was restricted solely to the researchers directly involved in the project.

During the deployment of the IoT vending machine prototype, care was taken to ensure that store operations were not disrupted and that all recorded data—such as sales and inventory logs—were used exclusively for research evaluation. Moreover, the researchers committed to academic integrity by accurately reporting findings, giving proper credit to referenced works, and avoiding any form of data fabrication, falsification, or plagiarism. These ethical practices were upheld not only to protect the participants but also to preserve the credibility, transparency, and reliability of the study's outcomes.

Chapter 4

RESULTS AND DISCUSSIONS

This chapter presents the results obtained from the development and evaluation of our system entitled "Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine". The discussions that follow highlight how the collected data, prototype testing, and user feedback were analyzed to validate the proposed solution's effectiveness in addressing the identified challenges of sari-sari store operations. The results gathered by this study are as follows:

Existing Sari-sari Store Operations

In the interviews with the client, as shown in Figure 5, the current approaches to inventory management and sales control of sari-sari stores, including those, which will be the intended users of Vendo Dito, Vendo Doon, is rather manual and traditional. Mostly the store owners utilize pen and paper systems, in which the owners of the stocks write down the prices of the commodities and maintain a check on the sales without any system of performing the same. The physical check of all containers or products is done to determine whether the supplies need to be replenished or not. All that the owner does when the products requiring the restock are identified is to write them down as a shopping list in a handwritten form. The restocking is done once every week or more than once a month based on the

revenue generated at a given time. Moreover, the choice of the most common products will be based only on the sight of the owner of the clientele and the stock remained. As far as financial monitoring is concerned the sari-sari store owners keep track of their sales as to the extent to which they spend money buying the products starting at the starting point and the extent to which they earn in terms of the cash which they have.This manual process often leads to inventory errors and delayed restocking.

Figure 5. Sari-Sari Store Current Practices Diagram

Despite being the most effective way of maintaining businesses, this mode is most likely to be inaccurate, inefficient, and susceptible to human error which normally creates huddles in monitoring their inventories, their sales and the determination of their profits.

Based on this existing operation a proposed system architecture was created to support the manual practice of the Sari-Sari Store. Highlighting the connection of the web-app with the IoT device demonstrating how both will

work.

The suggested system architecture provides the way the web-based application is integrated with the IoT-enabled vending machine to facilitate and automate the traditional processes of the sari-sari store. In this access, the customer connects to the web application with a computer or mobile phone and monitors inventory, product details, sales and vending activities. Every action of the user is sent to the web server where the application logic of the system is handled and the central point of communication between the client and the vending machine.

Identifying Information and System Requirements

To create the web-based IoT vending machine system, that will be applicable to the work of the sari- sari store, one will have to gather and analyze data concerning the internal operations of the store and the degree of technological literacy of the owners thereof. The paper has found that such points are among the elements that are critical, including the way in which store owners handle their sales, profits, product selection, and retail pricing. In addition, they understood what they do about their operations and this was through the knowledge of inventory management and specifically how they record and track entry and exit of products in the store. Based on this, the study could identify the gaps and limitations of the current practices that might be overcome by

implementing system features that would be used to automate and streamline processes. Another most significant factor was the aspect of the nature of products commonly sold at sari-sari stores and this factor helped inform the design of the vending machine prototype to make it applicable and relevant. This data served as the basis of defining both the hardware and software specifications of the suggested system with IoT capabilities to ensure that it would be able to meet the practical requirements of the store operators and, at the same time, be highly feasible and user-friendly.

The limitations are also demonstrated by the handwritten records presented in the photos provided by the client. These physical records underscore the reliance on manual tracking methods Such constraints emphasize the need for a more streamlined, automated system that can ensure accuracy, real-time updates, and easier accessibility of records.

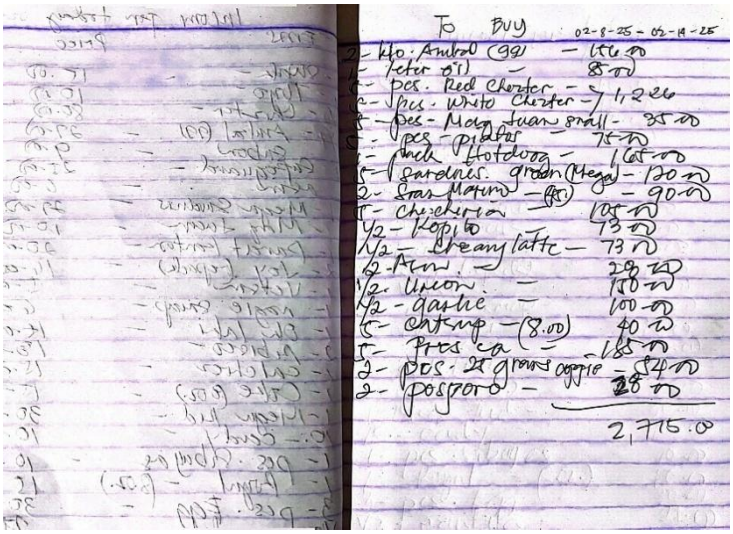

Figure 6. Weekly Record of To Buy of Owner

Figure 6 has a handwritten To Buy list, whereby the owner would list the things to be replenished and manually calculated the approximate cost. This shows how the decisions made by restocking are solely dependent on manual verification and personal estimation as opposed to the real-time inventory information.

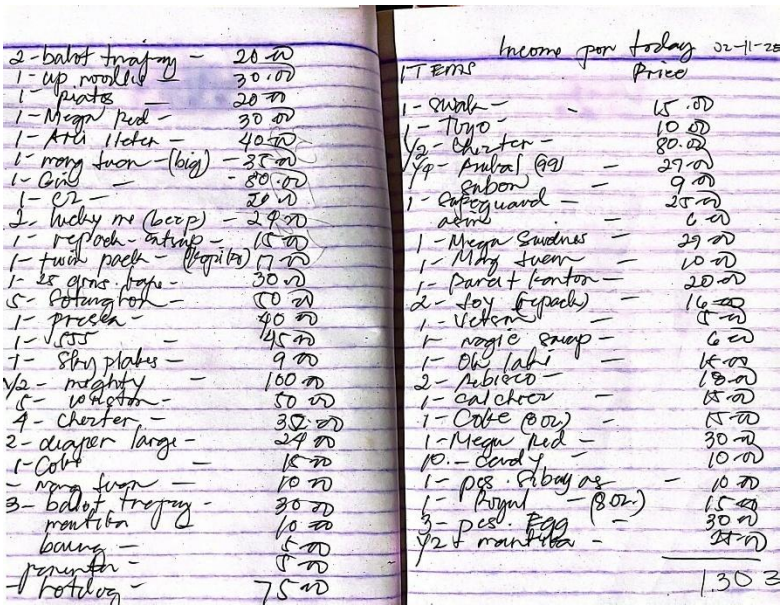

Figure 7. Daily Record of Incomes

While, Figure 7 is the daily records of incomes, in which each product sold is mentioned with its price and the total sales are calculated manually. These records point out the lack of automated sales tracking, real-time calculations and automated inventory tracking. Due to the handwritten entries, there is a great chance that entries like miscalculation, loss of items and inconsistencies will be recorded that validates the inefficiencies that were already identified in the interview process. Collectively, the attached images give solid factual evidence of the dfwedfe43 problems that sari-sari store owners have when

trying to uphold proper sales and inventory records without a digital system.

Moreover, the system requirements outline the necessary software and hardware elements to normalize the smooth running of the proposed web-based vending and inventory system.

Table 2. System Requirements

Software	Hardware
Windows 10/11 Android OS/iOS Google Chrome/Mozilla Firefox/ Apple Safari/ Microsoft Edge	Mobile Phones / Laptop/ Computer Internet Connectivity Power Outlet

At the software level shown in Table 2, the system supports the use of modern operating systems like Windows 10/11 by desktop users and Android or iOS by mobile users, making it accessible to the most used gadgets. It is also compatible with popular web browsers such as Google Chrome, Mozilla Firefox, Apple Safari, and Microsoft Edge, which enables users to use the web application without having to install other software. Hardware wise, the system is accessible by any mobile device, laptop, or desktop if it is stable through internet connection needed to have real-time communication with the IoT-enabled vending machine. There is also the need of a power outlet to power the vending machine apparatus itself. All in all, these

requirements make the system flexible, ubiquitous, and usable in a variety of platforms and environments.

Improved Inventory, Sales and Operations Features

Considering the issues revealed during the analysis of the current activities of the sari-sari store owners, the suggested IoT-based vending machine was developed as a full-fledged product that could help renew the procedures of inventory management, automatic sales monitoring, and increase the efficiency of working conditions. The system starts with a strong authentication and accounts management system in which a user can register, log on and secure their account by verifying their email and recovering their passwords. This will ensure that sensitive business data is not tampered with or abused by inexperienced hands since only authorized people, including the store owner or assigned employees, could access it.

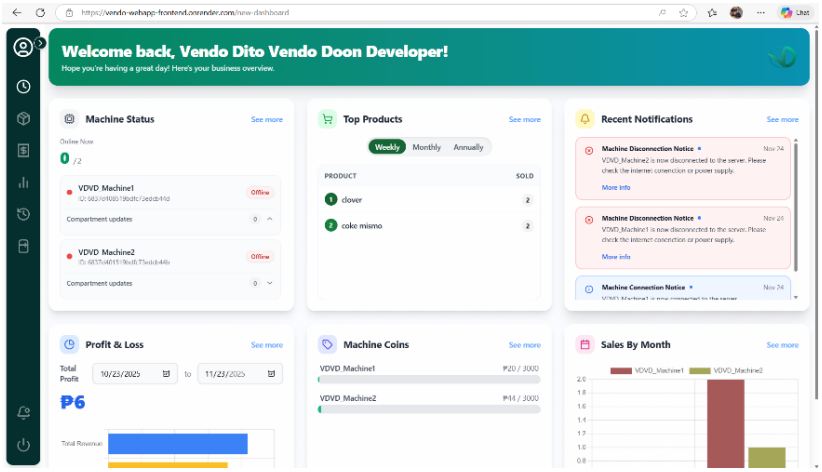

Figure 8. Dashboard Interface

The core dashboard is the main interface, Figure 8, which provides the sari-sari store owners with a quick glance at the business performance. This dashboard

summarizes the most important data, including the number of sales daily, the total profits, and the current inventory amount, and represents them in an interactive form as charts. To store owners who have always been used to only counting on the amount of cash in the bank and making rough estimates about sales, this feature is an eye-opener, giving a more factual data-driven view on what products are selling, when to restock and how the revenue in the store changes with time.

This kind of understanding would enable them to make better choices, such as focusing on fast-moving items or retiring products with low demand with the result of a more effective approach to managing stocks and increasing profitability.

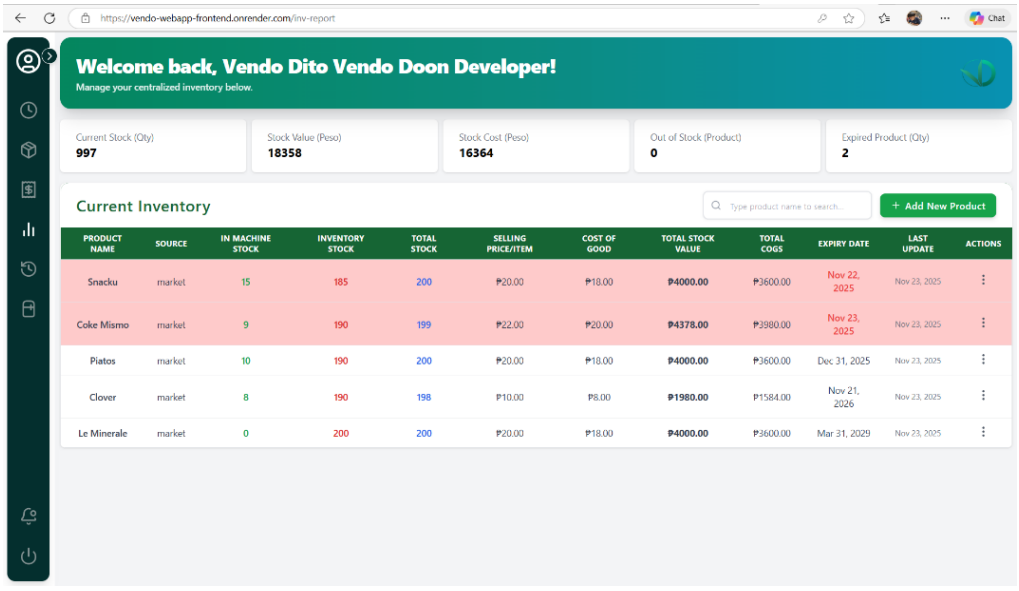

Figure 9. Inventory Management Interface

The inventory management interface in Figure 9 also boosts the operations of the store by putting the information on products on a single digital platform. Every

item may be documented using specific characteristics, including the name of the product, its origin, price, selling price, expiration date, and the amount of this item in stock. This does not only remove the inefficiencies of the manual checking but also helps to avoid the expensive errors like stockouts or the unnoticeable builds up of expired goods.

To sari- sari stores owners who usually juggle with limited resources, it is important to know the precise value of stock available and not to waste it on stock since it is important to have a steady cash flow and maximize returns. Since having a sari-sari store is one's source of income, handling money is critical.

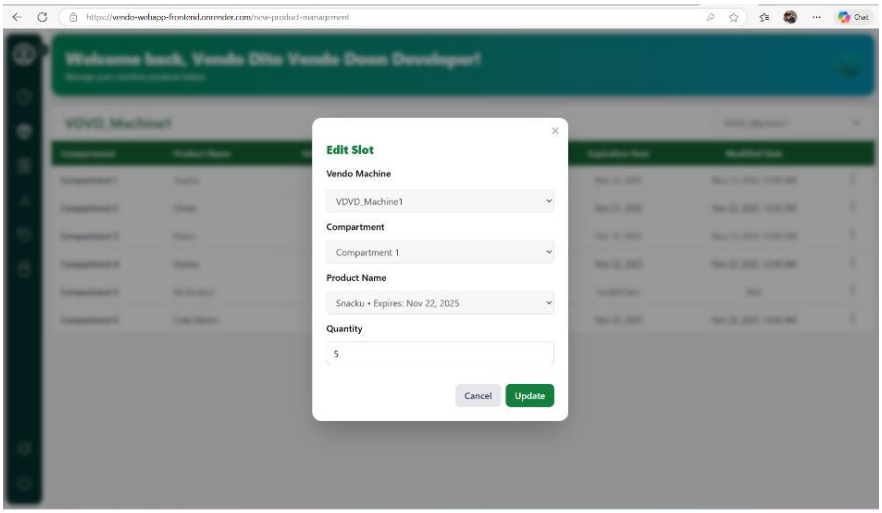

Figure 10. Product Management Interface

The system also has machine product management shown in Figure 10. This will enable the owners to adjust and revise the slots on the vending machine to suit demand so that the most reputable products are always provided to the customers. When combined with sales reporting programs,

which create reports about the point-of-sale transactions and product success, store owners obtain a strong tool to determine what products bring the highest income.

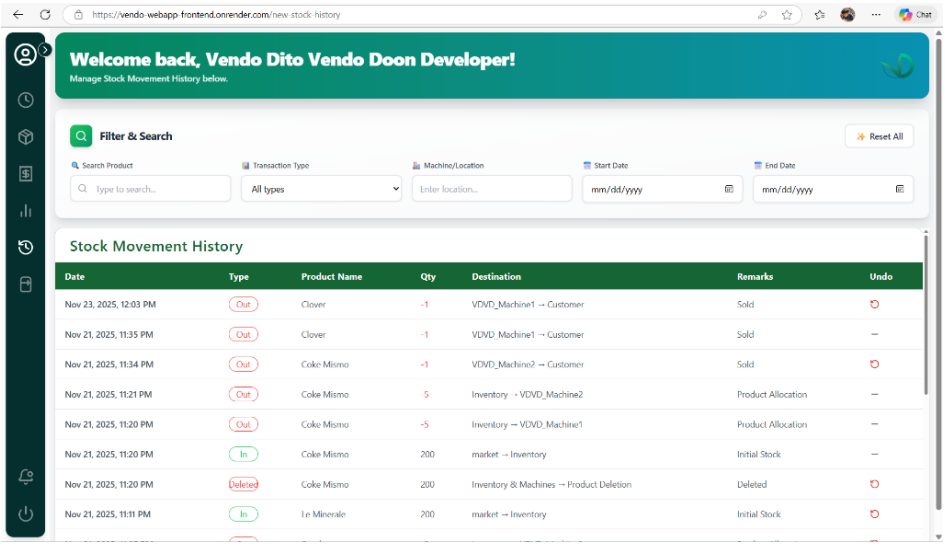

Figure 11. Stock Movement History Interface

The Stock Movement History interface in Figure 11 provides a centralized view of all inventory transactions within the IoT-based vending system, ensuring transparency and accountability. It records essential details such as the date and time of each transaction, transaction type (e.g., stock in, stock out, or deletion), product name, quantity moved, destination or source location (such as inventory or specific vending machines), and corresponding remarks like sales, product allocation, or initial stock. The built-in filter and search tools allow users to quickly locate specific records by product, transaction type, machine or location, and date range, making it easier to monitor stock flow, audit inventory activities, and support informed decision-making for sari-sari store and vending operations. This feature helps reduce inventory

discrepancies. It also ensures smoother operations.

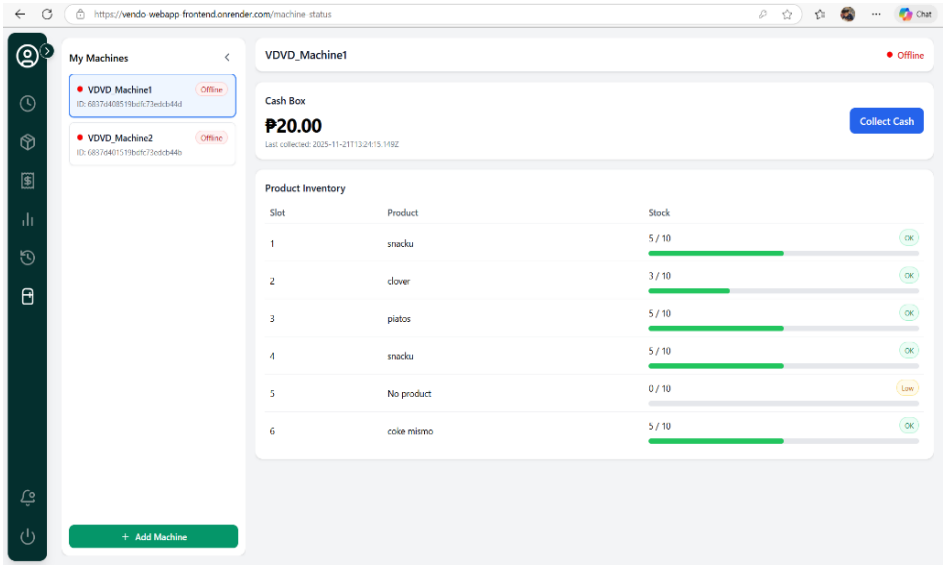

Figure 12. Machine Management Interface

The Machine Status and Inventory Monitoring interface in Figure 12 provides a centralized overview of the operational condition and stock levels of each vending machine within the IoT-based vending system. It displays the selected machine's connectivity status (online or offline), current cash box balance, and a detailed product inventory list showing slot numbers, assigned products, and remaining stock levels with visual indicators for normal, low, or empty items. Action buttons such as cash collection support efficient on-site operations, while the machine list panel allows quick switching between multiple machines. Overall, this interface enables administrators to remotely monitor machine performance, track product availability, identify restocking needs, and manage cash handling effectively, ensuring smooth and continuous vending operations. Additionally, the real-time

visualization of machine and inventory data reduces manual checking, minimizes downtime, and supports faster, data-driven decision-making for system administrators.

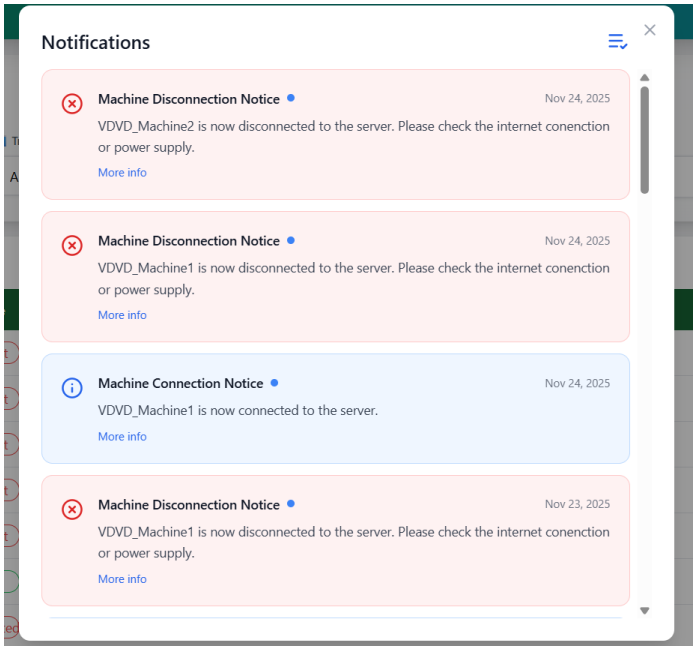

Figure 13. Notifications

The Notifications interface in Figure 13 provides a real-time log of system alerts related to the connectivity status of vending machines within the IoT-based vending system. It records important events such as machine disconnections and reconnections, indicating which specific machine is affected, the nature of the event, and the date it occurred. Visual cues, including color-coded notification cards and icons, help users quickly distinguish between warning alerts and informational updates. By centralizing these notices, the interface enables administrators to promptly detect connectivity issues, take corrective actions such as checking power or internet connections, and ensure continuous monitoring and

reliable operation of all vending machines in the system.

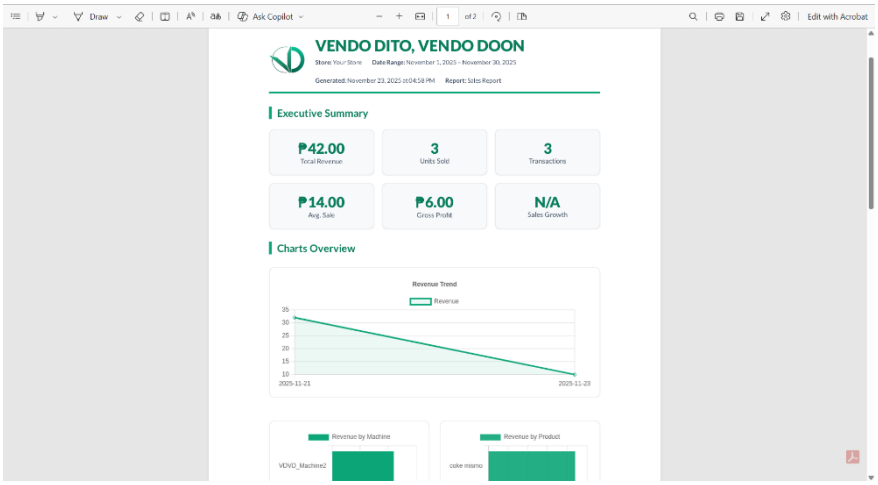

Figure 14. Sales Report PDF export

Lastly, the system combines report creation and PDF export options, as shown in Figure 14, enabling store owners to create professional records of their sales and inventory performance. In the case of small-time retailers such as the operators of sari-sari stores, such reports can be used as internal sources as well as submitted as collateral documents when seeking financial loans, business expansion initiatives, or business partnerships. Through the facilitation of the transition between the manual operations and the digital reporting system, the sari-sari store owners will have sufficient time to become more professionalized in how the business is conducted without the need to be frightened by overly complicated systems.

Conventionally, storekeepers use experience, bookkeeping and even intuition to operate their businesses, which in most cases results in inefficiencies, loss of opportunity and even losses. The system will enable the

store owners to be more accurate, reliable, and more foreseeable since it introduces IoT-enabled monitoring, and automated reporting as shown in Figure 12. It eases the burden of manual record-keeping, decreases inventory errors, eliminates financial leakages, and offers action-based insights into growth.

Evaluation Results of Metrics and Criteria for the Implemented System

The assessment of the adopted system of IoT based vending and inventory management was done based on the ISO/IEC 25010 quality framework with the support of the descriptive statistics and the feedback of the thirty (30) sari-sari store owners, including the main client. This evaluation was done to understand the effectiveness of the system in post deployment as per functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. The results all prove the efficiency of the system in dealing with the operational issues detected during the previous steps of the research.

Table 3 presents the respondents' assessment of the system's functional performance in terms of completeness and accuracy. Store owners strongly agreed that the system provides all the necessary functions required for effective inventory and vending machine management, as reflected by the high weighted mean of 4.47. Likewise, they strongly

agreed that the information displayed by the system is accurate and reliable, particularly in terms of stock levels and refill notifications, which obtained a weighted mean of 4.57. The pooled weighted mean of 4.52 further indicates an overall Strongly Agree interpretation, confirming the system consistently meets its requirements.

Table 3. Functional Stability of the System and Device

Statement	Weighted Mean	Interpretation
1. The system provides needed functions	4.47	Strongly Agree
2. Information displayed is accurate	4.57	Strongly Agree
Pooled Weighted Mean	4.52	Strongly Agree

Table 4 shows that respondents provided a generally positive evaluation of the system's performance. Store owners agreed that the system responds quickly to user actions, as indicated by a weighted mean of 4.30, suggesting that common tasks such as monitoring inventory and viewing machine status can be performed without noticeable delays. They also strongly agreed that the device operates smoothly even during multiple or continuous transactions, which obtained a higher weighted mean of 4.60. The pooled weighted mean of 4.45 reflects an overall Agree interpretation, indicating that the system meets

acceptable performance efficiency standards for real-time vending and inventory applications. This shows the system reliably supports daily store operations.

Table 4. Performance Efficiency of the System and Device

Statement	Weighted Mean	Interpretation
1. System responds quickly	4.30	Agree
2. Device operates smoothly	4.60	Strongly Agree
Pooled Weighted Mean	4.45	Agree

Table 5 presents the respondents' evaluation of how well the system integrates with existing store operations and different devices. Store owners strongly agreed that the system integrates smoothly with their daily store workflows, as reflected by the weighted mean of 4.33, indicating minimal disruption to current practices. They also strongly agreed that the system works effectively across various devices, such as smartphones and personal computers, which received a higher weighted mean of 4.63. The pooled weighted mean of 4.48 further confirms an overall Strongly Agree interpretation, suggesting that the system demonstrates high compatibility and flexibility. These findings imply that the system can be readily adopted in different retail environments. This makes it suitable

for broader adoption in small stores.

Table 5. Compatibility of the System

Statement	Weighted Mean	Interpretation
1. Integrates well with store operations	4.33	Strongly Agree
2. Works with different devices	4.63	Strongly Agree
Pooled Weighted Mean	4.48	Strongly Agree

Table 6 presents the respondents' evaluation of the system's ease of use and learnability. The results show that users strongly agreed that the system interface is easy to understand, obtaining the highest weighted mean of 4.57, indicating that users can quickly navigate and comprehend the system's features. Additionally, the system can be operated with minimal training, as reflected by a weighted mean of 4.50, which is especially important for micro-entrepreneurs who have limited time for extensive training. The clarity of instructions and labels also received a strong agreement rating with a weighted mean of 4.43, suggesting that the system provides clear guidance for users during operation. The pooled weighted mean of 4.50 further confirms that the system demonstrates a high level of usability. The high usability ratings indicate that the system effectively supports users in ease, thereby understanding, learning, and operating its functions with

meeting international software quality benchmarks and ensuring a positive and efficient user experience. This ease of use promotes quick adoption and consistent operation by store owners.

Table 6. Usability of the System and Device

Statement	Weighted Mean	Interpretation
1. Interface is easy to understand	4.57	Strongly Agree
2. Can operate with minimal training	4.50	Strongly Agree
3. Instructions and labels are clear	4.43	Strongly Agree
Pooled Weighted Mean	4.50	Strongly Agree

Table 7. presents the respondents' evaluation of the system's ability to operate consistently and recover from disruptions. Store owners strongly agreed that the system performs consistently during regular operations, as indicated by a weighted mean of 4.57. Moreover, they strongly agreed that the system can easily recover from interruptions such as power outages or network connectivity issues, which achieved a higher weighted mean of 4.70. The pooled weighted mean of 4.64 further confirms an overall Strongly Agree. However, minor performance variations may still occur under extreme or prolonged disruptions. Overall, the system demonstrates resilient operation.

Table 7. Reliability of the System

Statement	Weighted Mean	Interpretation
1. Performs consistently	4.57	Strongly Agree
2. Recovers easily from interruptions	4.70	Strongly Agree
Pooled Weighted Mean	4.70	Strongly Agree

Table 8 presents the respondents' evaluation of the system's security. Store owners strongly agreed that the system ensures secure storage (WM = 4.50) and protects user privacy (WM = 4.60). The pooled weighted mean of 4.55 indicates an overall Strongly Agree, confirming that the system provides a high level of security and effectively safeguards sensitive information.

Table 8. Security of the System

Statement	Weighted Mean	Interpretation
1. Data is stored securely	4.50	Strongly Agree
2. Protects privacy and transaction details	4.60	Strongly Agree
Pooled Weighted Mean	4.55	Strongly Agree

Table 9 reflects the respondents' evaluation of how easily the system can be maintained and updated. Both

indicators received a weighted mean of 4.60, showing that store owners strongly agreed that the system is straightforward to update and that errors can be efficiently fixed. This high rating suggests that the system has a modular and well-structured design, enabling prompt troubleshooting and reducing downtime. According to the ISO/IEC 25010 quality standard, maintainability is a key software quality characteristic that ensures a system can be modified, corrected, or enhanced effectively with minimal effort. While the evaluations are positive, there remains room for incremental improvements in maintainability to further optimize the system's lifecycle support. This ease of maintenance supports long-term system reliability and efficiency.

Table 9. Maintainability of the System

Statement	Weighted Mean	Interpretation
1. Easy to update and maintain	4.60	Strongly Agree
2. System errors can be fixed easily	4.60	Strongly Agree
Pooled Weighted Mean	4.60	Strongly Agree

Table 10 reflects the respondents' evaluation of how easily the system can be transferred and used across different platforms and devices. Both indicators—its ability to run on various platforms and the ease of

installation on new devices—received a perfect weighted mean of 4.80, indicating strong agreement among store owners. his high portability ensures that the system can be seamlessly deployed across different hardware or software setups, enhancing its applicability to diverse retail scenarios and improving scalability for future expansions. High portability makes the system adaptable for a wide range of retail environments.

Table 10. Portability of the System

Statement	Weighted Mean	Interpretation
1. Can run on different platforms	4.80	Strongly Agree
2. Easy to install on another device	4.80	Strongly Agree
Pooled Weighted Mean	4.80	Strongly Agree

Generally, quantitative assessment findings, which are backed by the qualitative presentation through interviews, confirm that the IoT-based vending and inventory management system addressed the needs of the owners of the sari-sari stores by improving the efficiency of operations, manual tracking reduction, stockouts avoidance, and decision-making in the process of restocking. The excellent scores of all the ISO/IEC 25010 quality features prove the success of the system in providing a safe, efficient, user-oriented, and highly

flexible solution to the small-scale retail business.

Table 11. Summary of System and Device Evaluation

Quality Criteria	Pooled Weighted Mean	Interpretation
Functional Stability	4.52	Strongly Agree
Performance Efficiency	4.45	Agree
Compatibility	4.48	Strongly Agree
Usability	4.50	Strongly Agree
Reliability	4.70	Strongly Agree
Security	4.55	Strongly Agree
Maintainability	4.60	Strongly Agree
Portability	4.80	Strongly Agree
Overall Mean	4.56	Strongly Agree

Based on the ISO/IEC 25010 model and feedback from 30 store owners, it showed high ratings across all quality attributes. With an overall mean in Table 11 of 4.58 (Strongly Agree), the system proved functionally complete, reliable, secure, user-friendly, and portable, effectively improving inventory accuracy, reducing manual workload, and providing a scalable solution for small retail businesses.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter presented the conclusions and recommendations that are relevant to the study.

Conclusions

The conclusions which are made following the results of the study are as follows:

1. The sari-sari stores are manually run and the handwritten sales records, restocking orders, and inventory perceptions indicate that there are significant inefficiencies that are impeding the effective sales tracking, inventory management, and profitability measurement. The photos of the client have also proven that a digital automated system is required, which promotes the creation of an IoT-driven vending and inventory system to eradicate such vulnerabilities in operations.

2. As revealed in the system and information requirements analysis, the development of an effective solution of IoT vending requires that the operations of the stores, movement of products and technological preparedness are understood. The analysis revealed the main problems of unorganized inventory records, the inability to track products, and the inability to make decisions based on the available data, which influenced the development of feasible, user-friendly hardware and software solutions, specifications that would be applicable to the daily sari-

sari stores operations. Understanding these requirements ensured the system effectively addresses real store challenges.

3. The implementation of the IoT-based vending machine with the web system shows that digital automation is a crucial advance in enhancing the effective operations of Sari-Sari stores. Such features as real-time monitoring of inventory, automated sales reporting, machine management tools, interactive dashboards, and PDF reporting can directly solve the issues observed in the traditional manual processes. The user-friendly interface, secure access, and data-driven tools facilitate the task of the system in helping store owners minimize errors, make superior decisions, and enhance business professionalism which supports the idea that the prototype is an effective modernization tool in micro-retail stores.

4. The system evaluation demonstrates that the solution is of the expected quality and in certain aspects, it is even over the expected quality. The findings have shown that the system is precise, receptive, easy to use, safe, trustworthy, and flexible to various gadgets and settings. These results indicate that the system is accurate, responsive, easy to use, secure, stable, and adaptable to different devices and environments.

Recommendations

Recommendations based on findings and conclusions of

the study are as follows:

1. Implement the system and automate it in the use of sari-sari stores to eliminate the manual and inefficient system used and enhance the overall business productivity. The integration of the system into the real store processes would also allow validating the system performance better, to make sure that it can be used to support the day-to-day operations of the retail enterprise.

2. A more sophisticated analytics module that can come up with predictive and actionable insights to inform business decisions. This involves finding the products that are selling well, the busiest times, the re-stocking requirements and the detection of abnormal stock movement.

3. Enhance user convenience by adding secure online payments, including e-wallets and QR codes, to simplify sales tracking and increase revenue. Install an alarm that triggers if the machine is forcibly opened and automatically locks when unattended. Construct the machine with durable, tamper-resistant materials to ensure maximum physical security.

4. More secured system is also recommended which is done by enhancing system security through the implementation of frequent updates and better access controls to prevent cybersecurity attacks on user data, financial records, and inventory information.

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APPENDICES

APPENDIX A

Certification of the Editor

CERTIFICATION OF THE EDITOR

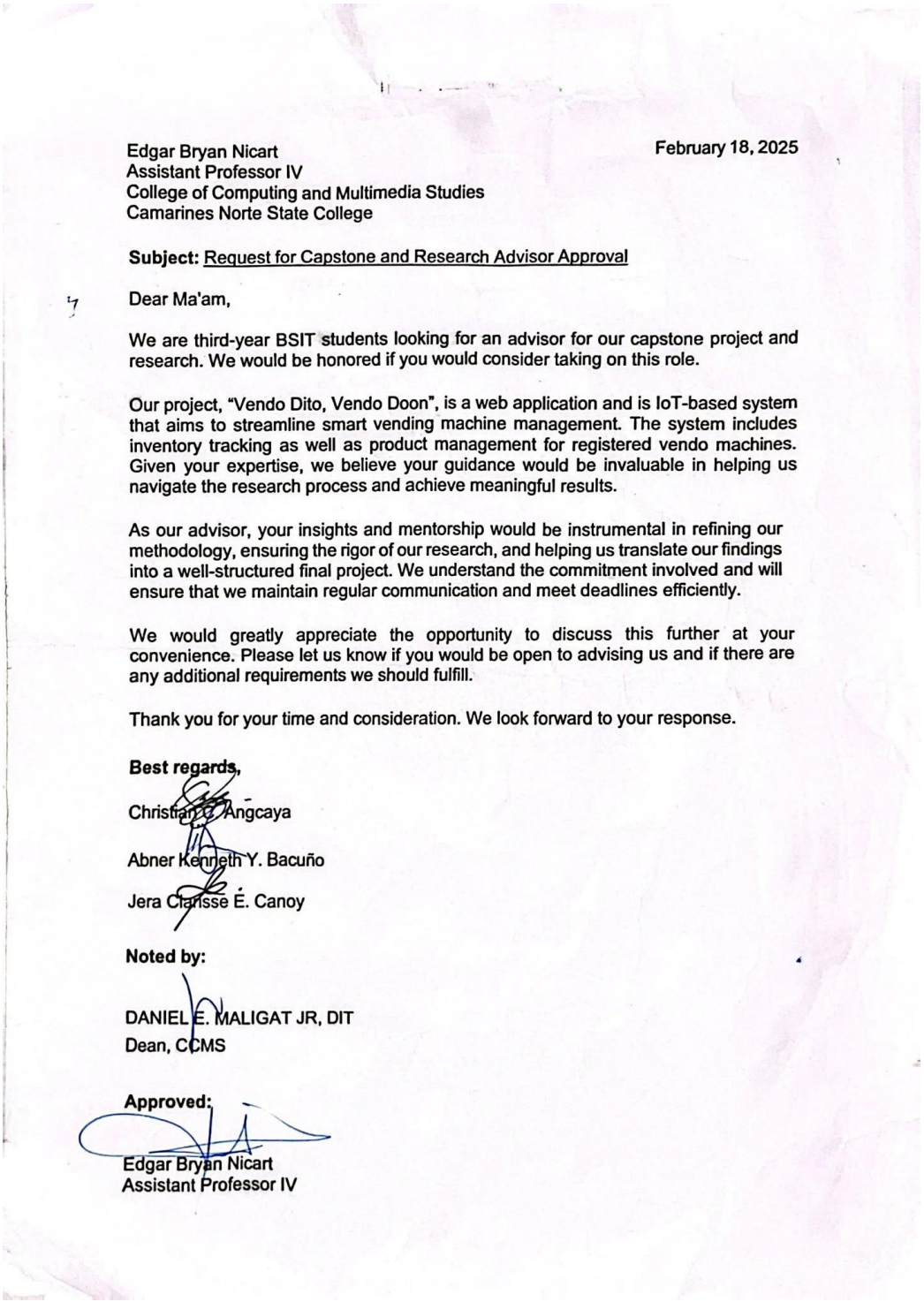
This is to certify that the Capstone Project entitled "Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine" prepared and submitted by Christian C. Angcaya, Abner Kenneth Y. Bacuño, and Jera Clarisse E. Canoy was edited by the undersigned.

This certificate is issued on this 16th day of December 2025 to attest to the completion of the editing process.

JONERALYN AIRA Y. BACUÑO, LPT
Editor

APPENDIX B

Request Letter for Adviser



Edgar Bryan Nicart
Assistant Professor IV
College of Computing and Multimedia Studies
Camarines Norte State College

February 18, 2025

Subject: Request for Capstone and Research Advisor Approval

Dear Ma'am,

We are third-year BSIT students looking for an advisor for our capstone project and research. We would be honored if you would consider taking on this role.

Our project, "Vendo Dito, Vendo Doon", is a web application and is IoT-based system that aims to streamline smart vending machine management. The system includes inventory tracking as well as product management for registered vendo machines. Given your expertise, we believe your guidance would be invaluable in helping us navigate the research process and achieve meaningful results.

As our advisor, your insights and mentorship would be instrumental in refining our methodology, ensuring the rigor of our research, and helping us translate our findings into a well-structured final project. We understand the commitment involved and will ensure that we maintain regular communication and meet deadlines efficiently.

We would greatly appreciate the opportunity to discuss this further at your convenience. Please let us know if you would be open to advising us and if there are any additional requirements we should fulfill.

Thank you for your time and consideration. We look forward to your response.

Best regards,

Christian C. Angcaya

Abner Kenneth Y. Bacuño

Jera Clarisse E. Canoy

Noted by:

DANIEL E. MALIGAT JR, DIT
Dean, CCMS

Approved:

Edgar Bryan Nicart
Assistant Professor IV

APPENDIX C

Letter for Client Approval

March 13, 2025

Greetings!

We are the 3rd year Bachelor of Science in Information Technology students from Camarines Norte State College. This letter aligns with our IT-121 Capstone Project and Research 1 course for the technical development of software systems to solve modern community problems efficiently.

In this regard, we humbly ask your permission to interview you about the management of your Sari-Sari Store in our research study entitled ***"Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine"***. This interview will help us reach our goal in our research which is to assess the process behind Sari-Sari Stores. Thus, your active cooperation, expertise, and insights will be essential in completing this research study and digital system. Rest assured that the collected data will be under confidentiality and the proponent exclusivity and shall be only used for academic purposes.

Thank you very much for your time and consideration.

Respectfully Yours,

ANGCAYA, CHRISTIAN C.

BACUÑO, ABNER KENNETH Y.

CANOY, JERA CLARISSE E.

Noted:

DANIEL E. MALIGAT JR., DIT
Dean/Capstone Project and Research 1 Moderator

Approved:

MONINA E. CANOY
Sari-Sari Store Owner

APPENDIX D

Letter for Pre-Final Defense

October 29, 2025

DANIEL E. MALIGAT JR., DIT
Capstone Project and Research 2 Professor
College of Computing and Multimedia Studies

Sir:

This is to formally inform you that, in compliance with the requirements for the Bachelor of Science in Information Technology program, our group has successfully consulted with our assigned panel members regarding our Capstone Project entitled **"Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine"**

We are pleased to report that both panel members have reviewed our project, and we have already implemented and met all the recommendations and revisions they provided during our previous evaluation. The panel members have also expressed their agreement and approval that the project is now ready for the next stage of evaluation.

Thank you very much!

Panel Committee Members:

1. **BRYAN R. ARELLANO, MSIT**
   Member

   Signature — Date: 10-29-25

2. **SPENCER S. SALUDES, MIS**
   Member

   Signature — Date: 10-29-25

Respectfully yours,

ANGCAYA, CHRISTIAN C.

BACUNO, ABNER KENNETH Y.

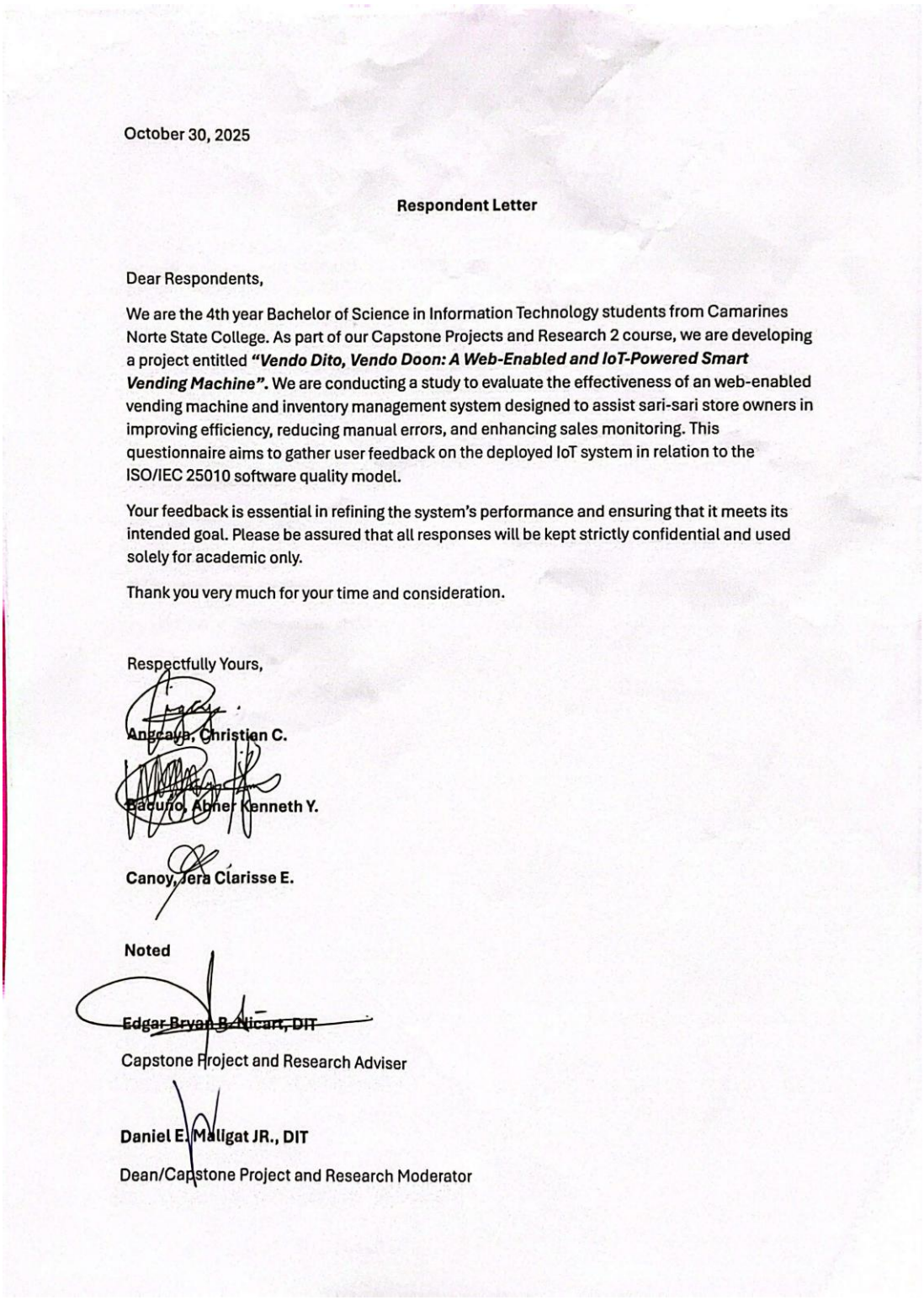
CANOY, JERA CLARISSE E.

Noted By:

DANIEL E. MALIGAT JR., DIT
Capstone Project and Research 2 Professor

APPENDIX E

Request Letter for Evaluation



October 30, 2025

Respondent Letter

Dear Respondents,

We are the 4th year Bachelor of Science in Information Technology students from Camarines Norte State College. As part of our Capstone Projects and Research 2 course, we are developing a project entitled ***"Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine"***. We are conducting a study to evaluate the effectiveness of an web-enabled vending machine and inventory management system designed to assist sari-sari store owners in improving efficiency, reducing manual errors, and enhancing sales monitoring. This questionnaire aims to gather user feedback on the deployed IoT system in relation to the ISO/IEC 25010 software quality model.

Your feedback is essential in refining the system's performance and ensuring that it meets its intended goal. Please be assured that all responses will be kept strictly confidential and used solely for academic only.

Thank you very much for your time and consideration.

Respectfully Yours,

Angcaya, Christian C.

Bacurio, Abner Kenneth Y.

Canoy, Jera Clarisse E.

Noted

Edgar Bryan B. Alicart, DIT

Capstone Project and Research Adviser

Daniel E. Mallgat JR., DIT

Dean/Capstone Project and Research Moderator

APPENDIX F

Request Letter for External Panel

December 02, 2025

MONINA E. CANOY
Sari-Sari Store Owner

Ma'am,

We, the fourth-year students pursuing a Bachelor of Science in Information Technology at Camarines Norte State College, are reaching out to you about our Capstone Project, ***"Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine"***.

Our study was directed at overcoming the old-time issues of functioning of traditional sari-sari stores, in particular, the necessity to manually track the inventory, to have a limited monitoring capacity, and to sporadically monitor sales. With Internet of Things (IoT) technologies and a web-based management dashboard, the system automatically dispensed the products, updated the inventory and recorded the sales, enabling owners of the store to see stock levels and transactions in real-time.

Furthermore, we would like to extend a formal invitation for you to serve as an external panelist during our final defense, which is scheduled for December 10, 2025 at _____. Your expertise and constructive feedback will be instrumental in refining our project ensuring its success.

We sincerely hope you will consider our request. We would greatly appreciate your support and look forward to your favorable response.

Thank you very much for your time and consideration.

Sincerely,

ANGCAYA, CHRISTIAN C.

BACUÑO, ABNER KENNETH Y.

CANOY, JERA CLARISSE E.

Noted:

EDGAR BRYAN B. NICART, DIT
Capstone Project and Research 2 Adviser

DANIEL E. MALIGAT JR., DIT
Dean/Capstone Project and Research Moderator

Approved:

MONINA E. CANOY
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APPENDIX G

Letter for Final Defense

December 02, 2025

DANIEL E. MALIGAT JR., DIT
Capstone Project and Research 2 Professor
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Sir:

In partial fulfillment of the requirement in Bachelor of Science in Information Technology program, the undersigned conducted a Capstone Project entitled **"Vendo Dito, Vendo Doon: A Web-Enabled and IoT-Powered Smart Vending Machine"**

In connection with this, the undersigned humbly request the following CCMS faculty as members of our panel committee. Apart from that, we would like to schedule our final defense on December 10, 2025, at 2:31 AM/PM.

Thank you very much!

Panel Committee Members:

1. **BRYAN R. ARELLANO, MSIT**
   Member — Signature — Date: 12/02/25

2. **SPENCER S. SALUDES, MIS**
   Member — Signature — Date: 12/02/25

Respectfully yours,

ANGCAYA, CHRISTIAN C.

BACUÑO, ABNER KENNETH Y.

CANOY, JERA CLARISSE E.

Noted By:

EDGAR BRYAN B. NICART, DIT
Capstone Project and Research 2 Adviser

DANIEL E. MALIGAT JR., DIT
Capstone Project and Research 2 Professor

APPENDIX H

Source Code

```
//server.js
import express from "express";
import dotenv from "dotenv";
import cookieParser from "cookie-parser";
import cors from "cors";
import http from "http";
import cron from "node-cron";
import path from "path";
import { fileURLToPath } from "url";

import { connectDB } from "./db/connectDB.js";
import authRoutes from "./routes/auth.route.js";
import userAndMachineCountsRoutes from
"./routes/userAndMachineCounts.routes.js";
import machineRoutes from "./routes/machine.route.js";
import productRoutes from "./routes/product.route.js";
import transactionRoutes from
"./routes/transactions.route.js";
import manageAdminRoutes from
"./routes/manageAdmin.route.js";
import initWebSocket from "./ws/websocket.server.js";
import notificationRoutes from
"./routes/notification.routes.js";
```

```
import stockMovementsRoutes from
"./routes/stockMovement.route.js";
import reportsRoutes from "./routes/reports.route.js";
import {
  checkExpirationStatuses,
  updateExpirationStatuses,
  watchProductStock,
} from "./services/product.service.js";
import {
  stockMovementWatcher,
  transactionWatcher,
} from "./services/analytics.service.js";
import {
  machineWatcher,
  cashCollectionChecker,
} from "./services/machine.service.js";

dotenv.config();

const __filename = fileURLToPath(import.meta.url);
const __dirname = path.dirname(__filename);

const app = express();
app.use(
  cors({
    origin: [
```

```
      "https://vendo-webapp-frontend.onrender.com",
      "http://localhost:5173",
    ], // your Vite React frontend
    credentials: true,
  })
);
app.use(cookieParser());

app.use("/static", express.static(path.join(__dirname,
"public")));
app.use(express.json()); // Middleware to parse JSON
requests

app.use("/api/auth", authRoutes);
app.use("/api", userAndMachineCountsRoutes);
app.use("/api", machineRoutes);
app.use("/api", productRoutes);
app.use("/api", transactionRoutes);
app.use("/api", manageAdminRoutes);
app.use("/api", notificationRoutes);
app.use("/api", stockMovementsRoutes);
app.use("/api", reportsRoutes);

const httpServer = http.createServer(app);
initWebSocket(httpServer);
const PORT = process.env.PORT || 5000;
```

```
httpServer.listen(PORT, () => {
  connectDB(); // Connect to the database when the server
starts
  console.log(`Server is running on port ${PORT}`);
  cron.schedule("0 0 * * *", async () => {
    try {
      await updateExpirationStatuses();
      await checkExpirationStatuses();
    } catch (err) {
      console.error("Error running expiration job:",
err);
    }
  });
  cron.schedule("0 */12 * * *", async () => {
    try {
      await cashCollectionChecker();
    } catch (err) {
      console.error("Error running cash collection
checker:", err);
    }
  });
  watchProductStock();
  transactionWatcher();
  stockMovementWatcher();
  machineWatcher();
});
```

```
// add product controller (product.controller.js)
export const addProduct = async (req, res) => {
  const {
    name,
    from,
    expirationDate,
    stock,
    costPrice,
    sellingPrice,
    storedAt,
  } = req.body;

  try {
    if (
      !name ||
      !from ||
      !expirationDate ||
      !stock ||
      !costPrice ||
      !sellingPrice ||
      !storedAt
    ) {
      return res
        .status(400)
```

```
        .json({ success: false, message: "All fields are
required" });
    }

    if (stock <= 0) {
      return res.status(400).json({
        success: false,
        message: "Quantity must be greater than zero.",
      });
    }

    const exp = new Date(expirationDate).setHours(0, 0,
0, 0);
    if (exp <= Date.now()) {
      return res.status(400).json({
        success: false,
        message: "You cannot add a product that has
already expired.",
      });
    }

    const existingProduct = await Product.findOne({
      name: name.toLowerCase(),
      storedAt,
      isDeleted: false,
      expirationDate,
```

```
    });
    if (existingProduct) {
      return res.status(400).json({
        success: false,
        message:
          "Product already exists. EDIT that instead to
avoid redundancy.",
      });
    }

    const product = new Product({
      name: name.toLowerCase(),
      image: "https://cdn-icons-
png.flaticon.com/128/1102/1102949.png",
      expirationDate,
      stock,
      from,
      costPrice,
      sellingPrice,
      storedAt: new mongoose.Types.ObjectId(storedAt),
    });

    await product.save();

    // const notificationTemplate = await
addProductNotif(product);
```

```
// const result = await createNotification({
//   userId: storedAt,
//   type: notificationTemplate.type,
//   title: notificationTemplate.title,
//   message: notificationTemplate.message,
//   details: notificationTemplate.details,
// });

// await wsService.broadcastToUser(storedAt, {
//   type: "new",
//   notifications: result.notification,
// });

await PostStockMovement({
  userId: storedAt,
  productName: name,
  type: "in",
  qty: stock,
  from,
  productBId: product._id,
  to: "Inventory",
  remarks: "Initial Stock",
});

return res.status(201).json({
  success: true,
```

```
      message: "Product added successfully",
      product: { ...product._doc },
    });
  } catch (error) {
    console.error("Error adding product:", error);
    return res.status(500).json({ success: false,
message: error.message });
  }
};

// add machine product controller (product.controller.js)
export const addMachineProduct = async (req, res) => {
  const { machineId, compartmentNumber, productId,
quantity, userId } =
    req.body;
  try {
    if (
      !machineId ||
      !compartmentNumber ||
      !productId ||
      !quantity ||
      !userId
    ) {
      return res
        .status(400)
```

```
        .json({ success: false, message: "All fields are
required." });
    }

    const product = await
Product.findById(productId).lean();
    if (
      product.expirationStatus === "expired" ||
      new Date(product.expirationDate) < new Date()
    ) {
      return res.status(400).json({
        success: false,
        message: "This product has expired.",
      });
    }

    const qty = Number(quantity);
    if (!Number.isInteger(qty) || qty <= 0) {
      return res.status(400).json({
        success: false,
        message: "Quantity must be a positive integer.",
      });
    }

    const machine = await
Machine.findById(machineId).lean();
```

```
    if (!machine) {
      return res.status(400).json({
        success: false,
        message: "Selected vending machine does not exist
for this user.",
      });
    }

    const session = await mongoose.startSession();
    session.startTransaction();
    try {
      // Find the stored product in the machine (if any)
      const storedProduct = await Product.findOne({
        storedAt: machineId,
        compartmentNumber,
        isDeleted: false,
      }).session(session);

      const productToAdd = await
Product.findById(productId).session(session);
      if (!productToAdd) {
        throw new Error("Product not found.");
      }

      if (productToAdd.stock <= 0) {
        throw new Error("That product is out of stock.");
```

```
      }
      if (qty > productToAdd.stock) {
        throw new Error(
          `Cannot add ${qty} items; only
${productToAdd.stock} in stock.`
        );
      }

      if (storedProduct) {
        // ensure same product and expiration
        if (
          storedProduct.name !== productToAdd.name ||
          storedProduct.expirationDate.getTime() !==
            productToAdd.expirationDate.getTime()
        ) {
          throw new Error(
            "Compartment contains a different product.
Remove it first to avoid conflicts."
          );
        }

        const total = storedProduct.stock + qty;
        if (total > 5) {
          throw new Error("Compartment capacity exceeded
(max 5 items).");
        }
```

```
          storedProduct.stock += qty;
          await storedProduct.save({ session });

          const postResult = await PostStockMovement({
            userId,
            productName: storedProduct.name,
            type: "out",
            qty: -qty,
            productAId: productToAdd._id,
            from: "Inventory",
            productBId: storedProduct._id,
            to: machine.machineName,
            remarks: "Replenishment",
            options: { session },
          });
          if (!postResult.success) throw new
Error(postResult.message);
        } else {
          const newProduct = new Product({
            compartmentNumber,
            name: productToAdd.name,
            from: machine.machineName,
            expirationDate: productToAdd.expirationDate,
            costPrice: productToAdd.costPrice,
            sellingPrice: productToAdd.sellingPrice,
```

```
            stock: qty,
            storedAt: machineId,
            image: "https://cdn-icons-
png.flaticon.com/128/1102/1102949.png",
          });
          await newProduct.save({ session });

          const postResult = await PostStockMovement({
            userId,
            productName: newProduct.name,
            type: "out",
            qty: -qty,
            productAId: productToAdd._id,
            from: "Inventory",
            productBId: newProduct._id,
            to: machine.machineName,
            remarks: "Product Allocation",
            options: { session },
          });
          if (!postResult.success) throw new
Error(postResult.message);
        }

        // decrement inventory product
        productToAdd.stock -= qty;
        await productToAdd.save({ session });
```

```
      await session.commitTransaction();
      session.endSession();

      // after commit: notify ESP (side-effect)
      await sendUpdatedProductsToESP(machine._id);

      return res.status(200).json({
        success: true,
        message: "Product added to machine
successfully.",
      });
    } catch (err) {
      await session.abortTransaction();
      session.endSession();
      return res.status(400).json({ success: false,
message: err.message });
    }
  } catch (error) {
    return res.status(500).json({ success: false,
message: error.message });
  }
};

// Arduino AtMega Codet
#include <ArduinoJson.h>
```

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
#include <U8g2lib.h>

// Initialize 128x64 ST7920 display (pins may be changed
if needed)
U8G2_ST7920_128X64_F_SW_SPI u8g2(U8G2_R0, /* clock=*/52,
/* data=*/51, /* cs=*/10, /* reset=*/8);

LiquidCrystal_I2C lcd(0x27, 16, 2);  // 16 columns, 2
rows

const int relaypin2 = 48;
const int relaypin1 = 49;
const int relaypin4 = 47;
const int relaypin3 = 46;
const int relaypin5 = 44;
const int relaypin6 = 45;

// Coin counter ========================== //
volatile int pulseCount = 0;
volatile unsigned long lastPulseTime = 0;
volatile bool coinInserted = false;

const byte coinPin = 2;  // Coin signal pin (yellow wire)
int totalAmount = 0;     // Total accumulated pesos
```

```
// Coin counter ========================== //

String inputBuffer = "";
bool messageComplete = false;

const int MAX_PRODUCTS = 26; // Max for letters a-z
String productIDs[MAX_PRODUCTS];
int compartments[MAX_PRODUCTS];
int sellingPrices[MAX_PRODUCTS];
int productStocks[MAX_PRODUCTS];            // ✅ Added
to track stock
String expirationStatuses[MAX_PRODUCTS];    // ✅ Added
to track expiration
int productCount = 0;

// Define buttons (6 buttons for compartments 1 to 6)
const int NUM_BUTTONS = 6;
const int buttonPins[NUM_BUTTONS] = {30, 31, 32, 33, 34,
35};

// ================= Helper: Clean incoming JSON
================= //
String cleanInput(String raw) {
  String cleaned = "";
  for (unsigned int i = 0; i < raw.length(); i++) {
```

```
    char c = raw[i];
    if ((c >= 32 && c <= 126) || c == '\n' || c == '\r')
{
      cleaned += c;
    }
  }
  return cleaned;
}
//
============================================================
======= //

void setup() {
  u8g2.begin();
  Serial.begin(9600);
  Serial1.begin(9600);

  pinMode(relaypin3, OUTPUT);
  pinMode(relaypin4, OUTPUT);
  pinMode(relaypin2, OUTPUT);
  pinMode(relaypin1, OUTPUT);
  pinMode(relaypin5, OUTPUT);
  pinMode(relaypin6, OUTPUT);

  digitalWrite(relaypin3, HIGH);
  digitalWrite(relaypin4, HIGH);
```

```
  digitalWrite(relaypin1, HIGH);
  digitalWrite(relaypin2, HIGH);
  digitalWrite(relaypin5, HIGH);
  digitalWrite(relaypin6, HIGH);

  lcd.begin(16, 2);
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Machine Ready!");
  lcd.setCursor(0, 1);
  lcd.print("Balance: ");
  lcd.print(totalAmount);

  pinMode(coinPin, INPUT_PULLUP);
  attachInterrupt(digitalPinToInterrupt(coinPin),
onPulse, FALLING);

  for (int i = 0; i < NUM_BUTTONS; i++) {
    pinMode(buttonPins[i], INPUT_PULLUP);
  }

  Serial.println("ATmega2560 Ready.");
  Serial.println("Waiting for product list from
ESP32...");
}
```

```
void loop() {
  // Receive JSON from ESP32
  while (Serial1.available()) {
    char c = Serial1.read();
    if (isPrintable(c) || c == '\n' || c == '\r' || c ==
'\t') {
      inputBuffer += c;
    }
    if (c == '\n') {
      messageComplete = true;
      break;
    }
  }

  if (messageComplete) {
    inputBuffer = cleanInput(inputBuffer);
    inputBuffer.trim();

    Serial.println("Raw input buffer:");
    Serial.println(inputBuffer);

    StaticJsonDocument<2048> doc;
    DeserializationError error = deserializeJson(doc,
inputBuffer);

    if (error) {
```

```
      Serial.print("JSON parse error: ");
      Serial.println(error.c_str());
    } else {
      Serial.println("Valid JSON received:");
      serializeJsonPretty(doc, Serial);

      if (doc.is<JsonArray>()) {
        JsonArray products = doc.as<JsonArray>();
        productCount = 0;

        for (JsonObject product : products) {
          const char* id = product["id"];
          int compartment = product["compartmentNumber"];
          int price = product["sellingPrice"];
          int stock = product["stock"];
          const char* expirationStatus =
product["expirationStatus"];

          if (productCount < MAX_PRODUCTS) {
            productIDs[productCount] = String(id);
            compartments[productCount] = compartment;
            sellingPrices[productCount] = price;
            productStocks[productCount] = stock;
// ✅ Store stock
```

```
            expirationStatuses[productCount] =
String(expirationStatus); // ✅ Store status
            productCount++;
          }
        }
        Serial.println("Product list updated.");
        displayProducts();
      } else {
        Serial.println("Received data is not a JSON
array.");
      }
    }

    inputBuffer = "";
    messageComplete = false;
  }

  // Coin pulse handling
  if (coinInserted && (millis() - lastPulseTime > 300)) {
    processCoin(pulseCount);
    pulseCount = 0;
    coinInserted = false;
  }

  // Button press handling
```

```
  for (int i = 0; i < NUM_BUTTONS; i++) {
    if (digitalRead(buttonPins[i]) == LOW) {
      int pressedCompartment = i + 1;
      bool found = false;

      for (int j = 0; j < productCount; j++) {
        if (compartments[j] == pressedCompartment) {
          int price = sellingPrices[j];
          int stock = productStocks[j];
          String status = expirationStatuses[j];

          // ✅ NEW CONDITION: Prevent dispense if
expired or empty
          if (stock <= 0 || status == "expired") {
            Serial.print("Cannot dispense C");
            Serial.print(pressedCompartment);
            if (stock <= 0) Serial.println(": EMPTY");
            else Serial.println(": EXPIRED");

            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("C");
            lcd.print(pressedCompartment);
            if (stock <= 0) lcd.print(": EMPTY");
            else lcd.print(": EXPIRED");
```

```
  lcd.setCursor(0, 1);
  lcd.print("Balance: ");
  lcd.print(totalAmount);
  delay(3000);

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Machine Ready!");
  lcd.setCursor(0, 1);
  lcd.print("Balance: ");
  lcd.print(totalAmount);

  found = true;
  delay(500);
  break;
}

// ✅ Product available and not expired
if (totalAmount >= price) {
  totalAmount -= price;
  String selectedID = productIDs[j];
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Disp: C");
```

```
            lcd.print(pressedCompartment);
            lcd.print(" P:");
            lcd.print(price);
            lcd.setCursor(0, 1);
            lcd.print("Bal: P");
            lcd.print(totalAmount);

            if (pressedCompartment == 1) motorOne();
            else if (pressedCompartment == 2) motorTwo();
            else if (pressedCompartment == 3)
motorThree();
            else if (pressedCompartment == 4)
motorFour();
            else if (pressedCompartment == 5)
motorFive();
            else if (pressedCompartment == 6) motorSix();

            Serial.print("Dispensing from compartment ");
            Serial.print(pressedCompartment);
            Serial.print(". Sending ID: ");
            Serial.println(selectedID);
            Serial1.println(selectedID);
            Serial.print("₱"); Serial.print(price);
Serial.println(" deducted.");
            Serial.print("Remaining balance: ₱");
Serial.println(totalAmount);
```

```
            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("Machine Ready!");
            lcd.setCursor(0, 1);
            lcd.print("Balance: ");
            lcd.print(totalAmount);

          } else {
            Serial.print("Insufficient balance for
compartment ");
            Serial.print(pressedCompartment);
            Serial.print(" (₱");
            Serial.print(price);
            Serial.println(" required)");

            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("C");
            lcd.print(pressedCompartment);
            lcd.print(": Need ₱");
            lcd.print(price);

            lcd.setCursor(0, 1);
            lcd.print("Insufficient Bal.");
            delay(3000);
```

```
            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("Machine Ready!");
            lcd.setCursor(0, 1);
            lcd.print("Balance: ");
            lcd.print(totalAmount);
          }

          found = true;
          delay(500);
          break;
        }
      }

      if (!found) {
        Serial.print("No product found for compartment
");
        Serial.println(pressedCompartment);

        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Out of stock!");
        lcd.setCursor(0, 1);
        lcd.print("Balance: ");
        lcd.print(totalAmount);
        delay(3000);
```

```
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Machine Ready!");
        lcd.setCursor(0, 1);
        lcd.print("Balance: ");
        lcd.print(totalAmount);
      }
    }
  }
}

// Interrupt service routine for coin pulse
void onPulse() {
  unsigned long now = micros();
  if (now - lastPulseTime > 2000) {
    pulseCount++;
    lastPulseTime = now;
    coinInserted = true;
  }
}

// Convert pulse count to peso value
void processCoin(int count) {
  int coinValue = 0;
```

```
  switch (count) {
    case 1: coinValue = 1; break;
    case 2: coinValue = 5; break;
    case 5: coinValue = 10; break;
    case 10: coinValue = 20; break;
    default:
      Serial.print(count);
      Serial.println(" pulses: Unknown coin");
      return;
  }

  totalAmount += coinValue;
  Serial.print("Total: ₱");
  Serial.println(totalAmount);

  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Machine Ready!");
  lcd.setCursor(0, 1);
  lcd.print("Balance: ");
  lcd.print(totalAmount);
}

// ================== Motor functions ==================
//
```

```
void motorOne() { digitalWrite(relaypin1, LOW);
delay(6500); stopMotorsOne(); }
void motorTwo() { digitalWrite(relaypin2, LOW);
delay(6500); stopMotorsOne(); }
void motorThree() { digitalWrite(relaypin3, LOW);
delay(6500); stopMotorsOne(); }
void motorFour() { digitalWrite(relaypin4, LOW);
delay(6500); stopMotorsOne(); }
void motorFive() { digitalWrite(relaypin5, LOW);
delay(6500); stopMotorsOne(); }
void motorSix() { digitalWrite(relaypin6, LOW);
delay(6500); stopMotorsOne(); }

void stopMotorsOne() {
  digitalWrite(relaypin1, HIGH);
  digitalWrite(relaypin2, HIGH);
  digitalWrite(relaypin3, HIGH);
  digitalWrite(relaypin4, HIGH);
  digitalWrite(relaypin5, HIGH);
  digitalWrite(relaypin6, HIGH);
}

// ================= OLED Display ================= //
void displayProducts() {
  char buffer[24];
  u8g2.firstPage();
```

```
  do {
    u8g2.setFont(u8g2_font_6x12_tr);
    const uint8_t screenW = 128;
    uint8_t colX[2] = {screenW / 4, (3 * screenW) / 4};
    uint8_t rowY[3] = {16, 32, 48};

    int index = 0;
    for (int row = 0; row < 3; row++) {
      for (int col = 0; col < 2; col++) {
        if (index < productCount) {
          String lineText = "";
          int stock = productStocks[index];
          String status = expirationStatuses[index];

          if (stock <= 0) {
            lineText = "C" + String(compartments[index])
+ ": EMPTY";
          } else if (status == "expired") {
            lineText = "C" + String(compartments[index])
+ ": EXP";
          } else {
            lineText = "C" + String(compartments[index])
+ ": P" + String(sellingPrices[index]);
          }
```

```
          snprintf(buffer, sizeof(buffer), "%s",
lineText.c_str());
          uint8_t textWidth = u8g2.getStrWidth(buffer);
          uint8_t x = colX[col] - (textWidth / 2);
          uint8_t y = rowY[row];
          u8g2.drawStr(x, y, buffer);

          index++;
        }
      }
    }
  } while (u8g2.nextPage());
}

// ESP32 code
#include <WiFiManager.h>
#include <EEPROM.h>
#include <WebSocketsClient.h>
#include <ArduinoJson.h>

WiFiManager wm;
WebSocketsClient webSocket;

const int resetButtonPin    = 4;
const int addButtonPin      = 15;
const int connectButtonPin  = 5;
```

```
const int redLed = 19;
const int greenLed = 21;



StaticJsonDocument<1024> receivedDoc;
JsonArray productsArray;

bool shouldSaveConfig = false;

// Buffer for Wi-Fi credentials
char ssid[32];
char pass[32];

// Save config callback
void saveConfigCallback() {
  Serial.println("Should save config");
  shouldSaveConfig = true;
}

void checkResetButton() {
  if (digitalRead(resetButtonPin) == LOW) {
    Serial.println("Reset button pressed.
Restarting...");
    delay(200); // debounce
```

```
    ESP.restart();
  }
}

// Save SSID and password to EEPROM
void saveCredentials(const char* newSSID, const char*
newPass) {
  Serial.println("Saving WiFi credentials to EEPROM...");
  for (int i = 0; i < 32; i++) {
    EEPROM.write(i, newSSID[i]);
    EEPROM.write(100 + i, newPass[i]);
  }
  EEPROM.commit();
}

// Read SSID and password from EEPROM
void readCredentials() {
  Serial.println("Reading WiFi credentials from
EEPROM...");
  for (int i = 0; i < 32; i++) {
    ssid[i] = EEPROM.read(i);
    pass[i] = EEPROM.read(100 + i);
  }
  ssid[31] = '\0';
  pass[31] = '\0';
```

```
  Serial.print("SSID: ");
  Serial.println(ssid);
  Serial.print("Password: ");
  Serial.println(pass);
}

void sendAllProductsToATmega(JsonArray products) {
  String jsonOut;
  serializeJson(products, jsonOut);
  Serial2.println(jsonOut);
}

void webSocketEvent(WStype_t type, uint8_t * payload,
size_t length) {
  if (type == WStype_TEXT) {
    Serial.printf("Received: %s\n", payload);

    DeserializationError error =
deserializeJson(receivedDoc, payload);
    if (error) {
      Serial.print("JSON deserialization failed: ");
      Serial.println(error.c_str());
      return;
    }

    if (receivedDoc["products"].is<JsonArray>()) {
```

```
      productsArray =
receivedDoc["products"].as<JsonArray>();
      Serial.println("Product list received and
stored.");

      for (JsonObject product : productsArray) {
        const char* id = product["id"];
        const char* name = product["name"];
        int compartment = product["compartmentNumber"];
        int stock = product["stock"];
        float price = product["sellingPrice"];
        const char* expirationStatus =
product["expirationStatus"];

Serial.printf("ID: %s | Name: %s | Compartment: %d |
Stock: %d | Price: %.2f | Expiration Date: %s\n",
              id, name, compartment, stock, price,
expirationStatus);

      }

      sendAllProductsToATmega(productsArray);
    } else {
      Serial.println("No valid 'products' array found in
payload.");
    }
```

```
  }
}

void setup() {
  pinMode(resetButtonPin, INPUT_PULLUP);
  pinMode(addButtonPin, INPUT_PULLUP);
  pinMode(connectButtonPin, INPUT_PULLUP);
  pinMode(redLed, OUTPUT);//redled
  pinMode(greenLed, OUTPUT);//greenled

  Serial.begin(115200);
  EEPROM.begin(512);
  Serial2.begin(9600, SERIAL_8N1, 16, 17); // RX=GPIO16,
TX=GPIO17

  Serial.println("ESP32 booted. Checking WiFi
buttons...");

  wm.setSaveConfigCallback(saveConfigCallback);
  digitalWrite(redLed, LOW);
  digitalWrite(greenLed, LOW);

  // --- Check WiFiManager button ---
  if (digitalRead(addButtonPin) == LOW) {
    delay(200);  // debounce
    digitalWrite(redLed, HIGH);
```

```
    Serial.println("WiFiManager button pressed. Starting
portal...");
    wm.resetSettings();  // Optional: clear saved WiFi
    wm.startConfigPortal("VM2_Wifi Manager");



    if (shouldSaveConfig) {
      saveCredentials(wm.getWiFiSSID().c_str(),
wm.getWiFiPass().c_str());
      Serial.println("Credentials saved. Restarting...");
      ESP.restart();
    }

  // --- Check connect button ---
  } else if (digitalRead(connectButtonPin) == LOW) {
    delay(200);  // debounce
    readCredentials();
    Serial.print("Connecting to: ");
    Serial.println(ssid);
    WiFi.begin(ssid, pass);

    unsigned long startAttemptTime = millis();
    while (WiFi.status() != WL_CONNECTED && millis() -
startAttemptTime < 10000) {
      Serial.print(".");
      delay(500);
```

```
    }

    if (WiFi.status() == WL_CONNECTED) {
      Serial.println("\nWiFi connected successfully.");
      digitalWrite(greenLed, HIGH);
      Serial.print("IP address: ");
      Serial.println(WiFi.localIP());
    } else {
      Serial.println("\nFailed to connect to WiFi.");
    }

  } else {
    Serial.println("No WiFi button pressed. Skipping WiFi
setup.");
  }

  // --- Setup WebSocket ---
  webSocket.beginSSL("vendo-webapp-backend.onrender.com",
443,
"/websocket?clientType=ESP32&clientIdentification=123456"
);
  webSocket.onEvent(webSocketEvent);
  webSocket.setReconnectInterval(5000);
}

void loop() {
```

```
  webSocket.loop();
  checkResetButton();

  if (Serial2.available()) {
    String inputStr = Serial2.readStringUntil('\n');
    inputStr.trim();

    if (inputStr != "") {
      Serial.printf("Selected product ID (string): %s\n",
inputStr.c_str());

      StaticJsonDocument<128> msgDoc;
      //msgDoc["type"] = "selectProduct";
      msgDoc["id"] = inputStr;
      msgDoc["action"] = "postTransaction";

      String jsonToSend;
      serializeJson(msgDoc, jsonToSend);
      webSocket.sendTXT(jsonToSend);

      Serial.println("Sent selected product ID to
server.");
    }
  }
}
```

APPENDIX I

ISO/IEC Benchmark Questionnaire Sample

QUESTIONNAIRE

Vendo Dito, Vendo Doon: A Web-Based and IoT-Enabled Vending Machine

Dear Respondents,

We are conducting a study to evaluate the effectiveness of an web-enabled vending machine and inventory management system designed to assist sari-sari store owners in improving efficiency, reducing manual errors, and enhancing sales monitoring. This questionnaire aims to gather user feedback on the deployed IoT system in relation to the ISO/IEC 25010 software quality model. Your responses will help assess how the system performs in terms of functionality, usability, reliability, and performance efficiency. The information collected will be used solely for academic research purposes and will remain strictly confidential. Participation in this study is voluntary, and you may choose to withdraw at any time without penalty. Please answer all questions honestly based on your experience. For statements that use a rating scale, kindly mark the box that best represents your opinion. Thank you for taking the time to participate in this study — your feedback is valuable in improving the IoT-based vending system and supporting small-scale retail innovation.

The Researchers

I. Store Profile

Instruction: Please check the answer based on your current situation.

How long have you been operating your sari-sari store?
(Gaano na katagal mong pinapatakbo ang iyong sari-sari store?)
☐ Less than 1 year ☐ 1-3 years ☐ 4-6 years ☐ More than 6 years

How many different products do you usually sell?
(Ilang iba't ibang produkto ang karaniwan mong ibinebenta?)
☐ Less than 20 ☐ 20-50 ☐ 51-100 ☐ More than 100

How do you currently track your inventory?
(Paano mo kasalukuyang sinusubaybayan ang iyong imbentaryo?)
☐ Manually (paper/pen) ☐ Spreadsheet or app ☐ POS system
☐ Other:_____

II. Inventory Management and Technology Readiness

Instruction: Please rate each statement according to your level of agreement.

Scale	Description
5	Strongly Agree
4	Agree
3	Neutral
2	Disagree
1	Strongly Disagree

#	Statement	5	4	3	2	1
1	I often experience running out of stock for popular products. *(Madalas akong maubusan ng stock ng mga patok na produkto.)*	☐	☐	☐	☐	☐
2	Tracking stock levels manually takes too much time. *(Ang mano-manong pagsubaybay ng dami ng stock ay kumakain ng sobrang oras.)*	☐	☐	☐	☐	☐
3	I sometimes overstock slow-moving items. *(Minsan ay nasosobrahan ako ng stock sa mga produktong mabagal ang benta.)*	☐	☐	☐	☐	☐

4	I would benefit from a system that automatically updates inventory levels. *(Makikinabang ako sa isang sistemang awtomatikong nag-a-update ng antas ng imbentaryo.)*	☐	☐	☐	☐	☐
5	I lose sales because of late or missed restocking. *(Nawawalan ako ng benta dahil sa huling o hindi nagawang pagre-restock.)*	☐	☐	☐	☐	☐
6	I find it hard to track which products sell the most. *(Nahihirapan akong subaybayan kung aling mga produkto ang pinakamabenta.)*	☐	☐	☐	☐	☐
7	I believe technology can improve my store's efficiency. *(Naniniwala ako na maaaring mapabuti ng teknolohiya ang kahusayan ng aking tindahan.)*	☐	☐	☐	☐	☐
8	I am willing to adopt an IoT-based inventory or vending system. *(Handa akong gumamit ng IoT-based na sistema para sa imbentaryo o vending.)*	☐	☐	☐	☐	☐

III. Post-Deployment Evaluation (ISO/IEC 25010 Benchmarks)

Instruction: Please rate your experience with the IoT-Based Vending System using the same 1-5 scale

A. Functional Stability

#	Statement	5	4	3	2	1
9	The system provides all the functions I need to manage inventory efficiently. *(Ang system ay nagbibigay ng lahat ng kailangang mga tungkulin upang mahusay na mapangasiwaan ang imbentaryo.)*	☐	☐	☐	☐	☐
10	The information displayed (e.g., stock count, restock alerts) is accurate and relevant. *(Ang impormasyong ipinapakita (hal. bilang ng stock, mga paalala sa restock) ay tumpak at may kaugnayan.)*	☐	☐	☐	☐	☐

B. Performance Efficiency

#	Statement	5	4	3	2	1
11	The system responds quickly to commands or actions. *(Mabilis tumugon ang system sa mga utos o aksyon.)*	☐	☐	☐	☐	☐
12	The device operates smoothly even during multiple transactions. *(Maayos na gumagana ang device kahit sa panahon ng maraming transaksyon.)*	☐	☐	☐	☐	☐

C. Compatibility

#	Statement	5	4	3	2	1
13	The IoT system integrates well with my existing store operations. *(Ang IoT system ay mahusay na naaangkop sa kasalukuyang operasyon ng aking tindahan.)*	☐	☐	☐	☐	☐
14	The system can be used with different devices (smartphone, PC, etc.). *(Maaaring gamitin ang system sa iba't ibang device (smartphone, PC, atbp.).)*	☐	☐	☐	☐	☐

D. Usability

#	Statement	5	4	3	2	1
15	The system interface is easy to understand and navigate. *(Madaling maintindihan at i-navigate ang interface ng system.)*	☐	☐	☐	☐	☐
16	I can operate the system with little or no training. *(Kaya kong gamitin ang system kahit kaunti o walang pagsasanay.)*	☐	☐	☐	☐	☐
17	Instructions and labels in the system are clear and helpful. *(Ang mga tagubilin at label sa sistema ay malinaw at kapaki-pakinabang.)*	☐	☐	☐	☐	☐

E. Reliability

#	Statement	5	4	3	2	1
18	The system performs consistently without frequent errors or crashes. *(Palaging maayos ang pagganap ng system nang walang madalas na error o crash.)*	☐	☐	☐	☐	☐
19	The system recovers easily from interruptions (e.g., power or internet loss). *(Madaling nakaka-recover ang system mula sa mga pagkaantala (hal. pagkawala ng kuryente o internet).)*	☐	☐	☐	☐	☐

F. Security

#	Statement	5	4	3	2	1
20	My data is stored securely and not accessible to unauthorized users. *(Ang aking datos ay ligtas na nakaimbak at hindi naa-access ng mga hindi awtorisadong tao.)*	☐	☐	☐	☐	☐
21	The system protects user privacy and transaction details. *(Pinoprotektahan ng sistema ang privacy ng gumagamit at mga detalye ng transaksyon.)*	☐	☐	☐	☐	☐

G. Maintainability

#	Statement	5	4	3	2	1
22	The system is easy to update and maintain. *(Madaling i-update at panatilihin ang system.)*	☐	☐	☐	☐	☐
23	System errors or issues can be fixed without difficulty. *(Ang mga error o problema sa system ay madaling maayos.)*	☐	☐	☐	☐	☐

H. Portability

#	Statement	5	4	3	2	1
24	The system can run on different environments or platforms if needed. *(Maaaring patakbuhin ang system sa iba't ibang kapaligiran o platform kung kinakailangan.)*	☐	☐	☐	☐	☐
25	It is easy to transfer or install the system on another device. *(Madaling ilipat o i-install ang sistema sa ibang device.)*	☐	☐	☐	☐	☐

Thank you for your participation! Your responses are important in evaluating and enhancing the Web-Based vending machine.

CURRICULUM VITAE

Christian C. Angcaya

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Daet, Camarines Norte
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SUMMARY:

An IT undergraduate from Camarines Norte State College, possessing a solid grasp of web fundamentals, including HTML, CSS, and modern utility-first frameworks like Tailwind CSS. Currently sharpening skills in JavaScript and experience in working with both relational databases like MySQL and NoSQL databases like MongoDB. Actively exploring the MERN stack (MongoDB, Express, React, Node.js) to build comprehensive full-stack web applications. Beyond web development, foundational knowledge in 3D modeling and game development has been established, utilizing tools such as 3Ds Max, Blender, Tinkercad, and the Unreal Engine to create visually engaging digital projects. Furthermore, experienced in Arduino Projects and possessing expertise in using the Arduino IDE for embedded systems and hardware programming.

PERSONAL BACKGROUND:

DATE OF BIRTH:	March 21, 2004
PLACE OF BIRTH:	Talisay, Camarines Norte
AGE:	21
SEX:	Male
HEIGHT:	5’4”
WEIGHT:	43 kgs.
CIVIL STATUS:	Single
CITIZENSHIP:	Filipino
RELIGION:	Roman Catholic

EDUCATIONAL BACKGROUND:

TERTIARY:	Camarines Norte State College A.Y. 2022 – 2026 BS Information Technology Daet, Camarines Norte
SECONDARY:	Camarines Norte Senior High School S.Y. 2020 – 2022 Daet, Camarines Norte Moreno Integrated School A.Y. 2016 – 2020 Daet, Camarines Norte
PRIMARY:	Daet Elementary School A.Y. 2010 – 2016 Daet, Camarines Norte

---

TECHNICAL SKILL

WEB DEVELOPMENT

- Solid understanding of HTML, CSS, and modern utility-first frameworks like Tailwind CSS. Currently enhancing JavaScript proficiency and exploring full-stack development using the MERN stack (MongoDB, Express, React, Node.js). Experienced with relational databases like MySQL and NoSQL solutions such as MongoDB.

3D MODELING & GAME DEVELOPMENT

- Foundational experience in creating 3D assets and digital environments using 3Ds Max, Blender, Tinkercad, and Unreal Engine. Capable of producing visually engaging models and interactive project elements.

EMBEDDED SYSTEMS & ARDUINO

- Skilled in developing Arduino-based projects, with hands-on experience using the Arduino IDE for hardware programming and prototyping.

PERSONAL CHARACTERISTICS

- Fast learner and problem-solver

- Eager to learn and naturally curious about emerging tech trends
- A good leader known for accountability and delegates effectively and trusts the team to own their work.
- Reliable Collaborator known for honesty and integrity.
- Quality-Driven and focused on continuous skill improvement.

- BITSCON Bicol IT Student Congress 2024 April 25 – 26, 2024
  Camarines Norte State College, Daet, Camarines Norte
- FROM SCROLL TO SKILL: Empowering Students and Job Seekers through AI
  March 14, 2025
  Our Lady of Lourdes Colleges Foundation, Daet, Camarines Norte
- Bridging the Digital and Physical: 3D Tech for Visionaries
  May 7, 2025
  Camarines Norte State College, Daet, Camarines Norte

REFERENCES:

- **DANIEL E. MALIGAT JR., DIT**
  CCMS, Dean
  Camarines Norte State College Daet, Camarines Norte
- **EDGAR BRYAN B. NICART, DIT**
  Asst. Professor IV
  Camarines Norte State College

I hereby certify that the pieces of information presented above are true and correct to the best of my knowledge and belief.

CHRISTIAN G. ANGCAYA

Abner Kenneth Y. Bacuño

Purok 1 Brgy. Camambugan,
Daet, Camarines Norte
09055424833
bacunoabnerkenneth@gmail.com

SUMMARY:

An IT undergraduate from Camarines Norte State College with a solid grasp of HTML and CSS, currently sharpening skills in modern JavaScript. Experienced in working with both MySQL and MongoDB and actively exploring the MERN stack to build full-stack web applications. Has foundational knowledge in 3D modeling and game development, using tools like 3Ds Max and Unreal Engine to create visually engaging digital projects.

PERSONAL BACKGROUND:

DATE OF BIRTH:	March 31, 2004
PLACE OF BIRTH:	Daet, Camarines Norte
AGE:	21
SEX:	Male
HEIGHT:	5’7”
WEIGHT:	45 kgs.
CIVIL STATUS:	Single
CITIZENSHIP:	Filipino
RELIGION:	Roman Catholic

EDUCATIONAL BACKGROUND:

TERTIARY:	Camarines Norte State College A.Y. 2021 – 2025 BS Information Technology Daet, Camarines Norte
SECONDARY:	Camarines Norte Senior High School S.Y. 2020 - 2022 Moreno Integrated School A.Y. 2016 – 2020

Daet, Camarines Norte

PRIMARY: Zurbano Elementary School
A.Y. 2010 – 2016
Daet, Camarines Norte

TECHNICAL SKILL

WEB DEVELOPMENT

- Solid understanding of HTML and CSS, and delving deeper into modern JavaScript. Experienced in working with relational databases like MySQL and NoSQL databases like MongoDB. Actively exploring the MERN stack for building dynamic and scalable full-stack web applications.

PROGRAMMING & DATABASES

- Solid understanding and experience with backend development concepts and API integration. Skilled in structuring and managing data for various application needs.

3D & GAME DEVELOPMENT

- Foundational knowledge in 3D modeling using 3Ds Max. Experience working with Unreal Engine to create visually engaging and interactive digital environments.

PERSONAL CHARACTERISTICS

- Deeply committed to projects and responsibilities
- Eager to learn and naturally curious about emerging tech trends
- Hardworking with strong perseverance
- Honest, reliable, and dependable in collaborative work
- Continuously striving to improve skills and produce high-quality results

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SEMINARS AND CONFERENCE ATTENDED

- BITSCON Bicol IT Student Congress 2024
  April 25 – 26, 2024
  Camarines Norte State College, Daet, Camarines Norte
- FROM SCROLL TO SKILL: Empowering Students and Job Seekers through AI
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  Daet, Camarines Norte

- **EDGAR BRYAN B. NICART, DIT**
  Asst. Professor IV

  Camarines Norte State College

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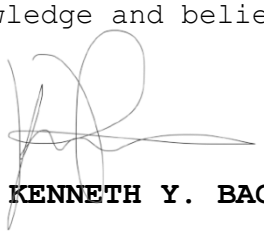

ABNER KENNETH Y. BACUÑO

Jera Clarisse E. Canoy

Purok 2, Brgy. Pag-asa
Jose Panganiban, Camarines Norte
09389081391
jeraclarissecanoy@gmail.com

SUMMARY:

An IT undergraduate from Camarines Norte State College with strong knowledge of Python, HTML, CSS, JavaScript, and MySQL. Has hands-on experience in website and application design, with a creative eye for building user-friendly and visually appealing digital solutions. Highly skilled in using Microsoft Office for document creation, data analysis, and producing creative, well-structured professional presentations. Dedicated, detail-oriented, and eager to continuously learn, is passionate about applying technical and creative skills to real-world projects and collaborative environments.

PERSONAL BACKGROUND:

DATE OF BIRTH:	April 13, 2004
PLACE OF BIRTH:	Pag-asa, Jose Panganiban, Camarines Norte
AGE:	21
SEX:	Female
HEIGHT:	5’”
WEIGHT:	55 kgs.
CIVIL STATUS:	Single
CITIZENSHIP:	Filipino
RELIGION:	Roman Catholic

EDUCATIONAL BACKGROUND:

TERTIARY:	Camarines Norte State College A.Y. 2022 – 2026 BS Information Technology Daet, Camarines Norte

SECONDARY:	Jose Panganiban National High School S.Y. 2020 – 2022 Jose Panganiban, Camarines Norte
	Jose Panganiban National High School A.Y. 2016 – 2020 Jose Panganiban, Camarines Norte
PRIMARY:	Pag-asa Elementary School A.Y. 2010 – 2016 Jose Panganiban, Camarines Norte

---

TECHNICAL SKILL

DATA ANALYSIS

- Knowledgeable in using vb.net and SQL for basic data cleaning, analysis, and querying of datasets. Able to create simple yet meaningful data visualizations and dashboards using Microsoft Visual Studio

MICROSOFT OFFICE SUITE

- Proficient in creating detailed and comprehensive documents using Microsoft Word. Skilled in managing, analyzing, and visualizing data with Microsoft Excel. Experienced in developing creative designs and compelling presentations using Microsoft PowerPoint.

PERSONAL CHARACTERISTICS

- Optimistic individual
- Motivated and hardworking
- Reliable
- Good Communicator
- Creative

SEMINARS AND CONFERENCE ATTENDED

- BITSCON Bicol IT Student Congress 2024 April 25 – 26,

2024

Camarines Norte State College, Daet, Camarines Norte

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- **EDGAR BRYAN B. NICART, DIT**
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I hereby certify that the pieces of information presented above are true and correct to the best of my knowledge and belief.

JERA CLARISSE E. CANOY