Progress in Engineering Application and Technology Vol. 4 No. 2 (2023) 415–424

PEAT

Homepage: http://penerbit.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-5303

Sales Monitoring System for Vending Machine Using Iot

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DOI: https://doi.org/10.30880/peat.2023.04.02.040
Received 03 July 2023; Accepted 12 July 2023; Available online 12 July 2023

Abstract: This project aims to develop an IoT-based sales monitoring system for vending machines. By integrating a voltage sensor with the vending machine and using the NodeMcu ESP32 Wi-Fi microcontroller, and ZMPT101b the system allows real-time monitoring of beverage sales through a web-based application powered by Google Sheets and no telemetry system for the owner to monitor the sales of the vending machine. The system provides updates to a Google Sheet, enabling vending machine owners to remotely track beverage sales and inventory status. This capability optimizes refill timings, reducing transportation costs. The objective includes developing an IoT system for monitoring vending machine beverages, integrating it with Google Sheets for cloud-based storage, and evaluating its performance in real-world settings. The NodeMcu ESP32 microcontroller acts as the central component, providing comprehensive sales reports for analyzing consumer behavior and optimizing operations. With IoT and cloud connectivity, this system offers vending machine owners a valuable tool for maximizing revenue and streamlining operations. Overall, it enhances vending machine operations by providing comprehensive visibility into beverage inventory and sales data, enabling data-driven decisions to improve efficiency and profitability.

Keywords: Vending Machine, Sales Monitoring System, Inventory Management, Real-Time Data Monitor, ESP 32 Module, Google Sheet

1. Introduction

A vending machine is an automated device that gives customers snacks and beverages once they insert money into it or make another payment. Early in the 1880s, England built the first sophisticated vending machines that gave out postcards. There are vending machines in many nations, and more recently, specialty vending machines have been developed that offer less popular products than typical vending machine fare. In the retail sector, vending machines are used to sell convenience goods, food, and non-food items. While selling hot and cold beverages has historically been the main vending machine business, more and more products and services are now available [1].

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In addition, a vending machine gives customers a variety of goods in exchange for money or another form of payment that can be inserted into the device. Vending machines are industrial equipment, hence the creation of products and technology in this space has mostly been restricted to the idea of cash processing and has been heavily needs-aligned [2]

Developing a sales monitoring system by using an IoT google sheet web-based application that will help users to use a notification based on sales in Vending Machine. In general, the Vending Machine labor normally check manually to vending machine place and refill the beverages to the slot to people buy the beverages [3]. A sensor that detects the beverage in the slot proposed in this work to solve the problem. So did some research of the vending machine, known there is no spacing for installing a sensor inside the slot because it fully fills with the beverages.

The problem statements are vending machine purchases might be regarded as typical buying situations. The customer is unable to request assistance, so they make the purchase on their own without consulting a shop employee. The customer gets taken care of immediately [4] if the sales process goes smoothly.

However, there is no telemetry system for the owner to monitor the sales of the vending machine [5]. The owner must physically come to the vending machine location to check the sales and refill the beverages. At the same time, the owner must bring along all the available beverages to the location for the refilling. This issue increases the cost of transportation and labor works [6].

This issue can be resolved by utilizing an IoT, where the vending machine has a monitoring system that can alert the service staff of the vending machine about the slot being empty or any errors so they can refill.

Objectives are to develop an IoT system for monitoring and managing beverages for vending machine, to integrate the IoT system of vending machine with a mobile application through cloud database and to evaluate the beverage sales monitoring capabilities and operational performance of the vending machine system in a real-world environment, with a focus on enhancing client experience, optimizing inventory management, and maximizing beverages sales revenue.

The scope are system requirements for remote monitoring are control application will run on the vending machine itself, gathering data from sensors and handling operation of the electromechanical aspects of the solution well as data exchange with both human users (e.g., technicians and administrators) with the google sheet cloud database system.

- The vending machine company would be able to monitor through a Google Sheet IoT platform that monitors the condition of the status of beverages from any internet connected mobile phone or computer so as for the company to know the status of their inventory management.
- Administration will monitor can operate on a PC or phone and allow for a detailed view into the sales of beverage in the vending machine, including events, status of beverages, and logs, as well as access to the cloud data and analytics. This application will report back to the database of the google sheet that stocking of that machine is lacking or no stockings status or certain percentage volume of beverages.

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study.

2.1 Materials

In this project, the materials used include the Nodemcu ESP32 microcontroller, Google Sheet web-based application and voltage sensor. The Nodemcu ESP32 serves as the main controller for the

monitoring system, while the data will be received at Google Sheet for data visualization and analysis [6]. To conduct the study, voltage sensors are utilized to collect real-time data from the PCB relay for voltage spike from relay to actuator. The sensors are connected to the Nodemcu ESP32, which gathers and processes the data [7]. The data collection process involves managing the inventory management to ensure accuracy and reliability of beverages sales in vending machine. The collected sales data is securely transmitted to the Google Sheet, which allows users to remotely monitor the beverages sales in real-time. Google Sheet provides visual representations such as the sales of each slot in the sheet to aid in data interpretation and analysis. To validate the accuracy of the system, the testing validation data collection is performed as a benchmark for obtained through the automated monitoring system.

2.2 System Block Diagram

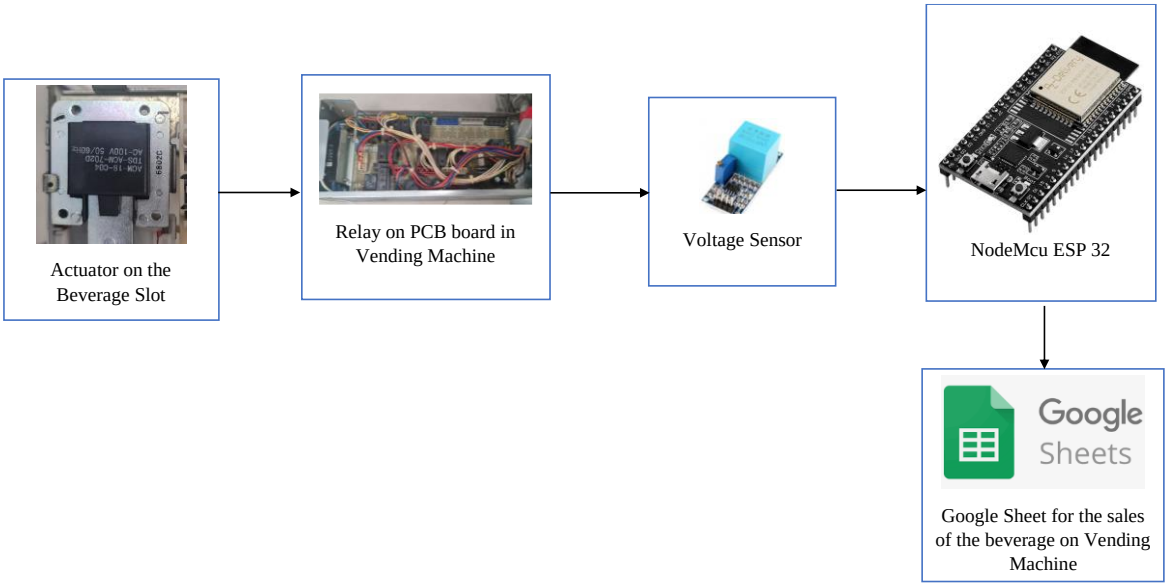
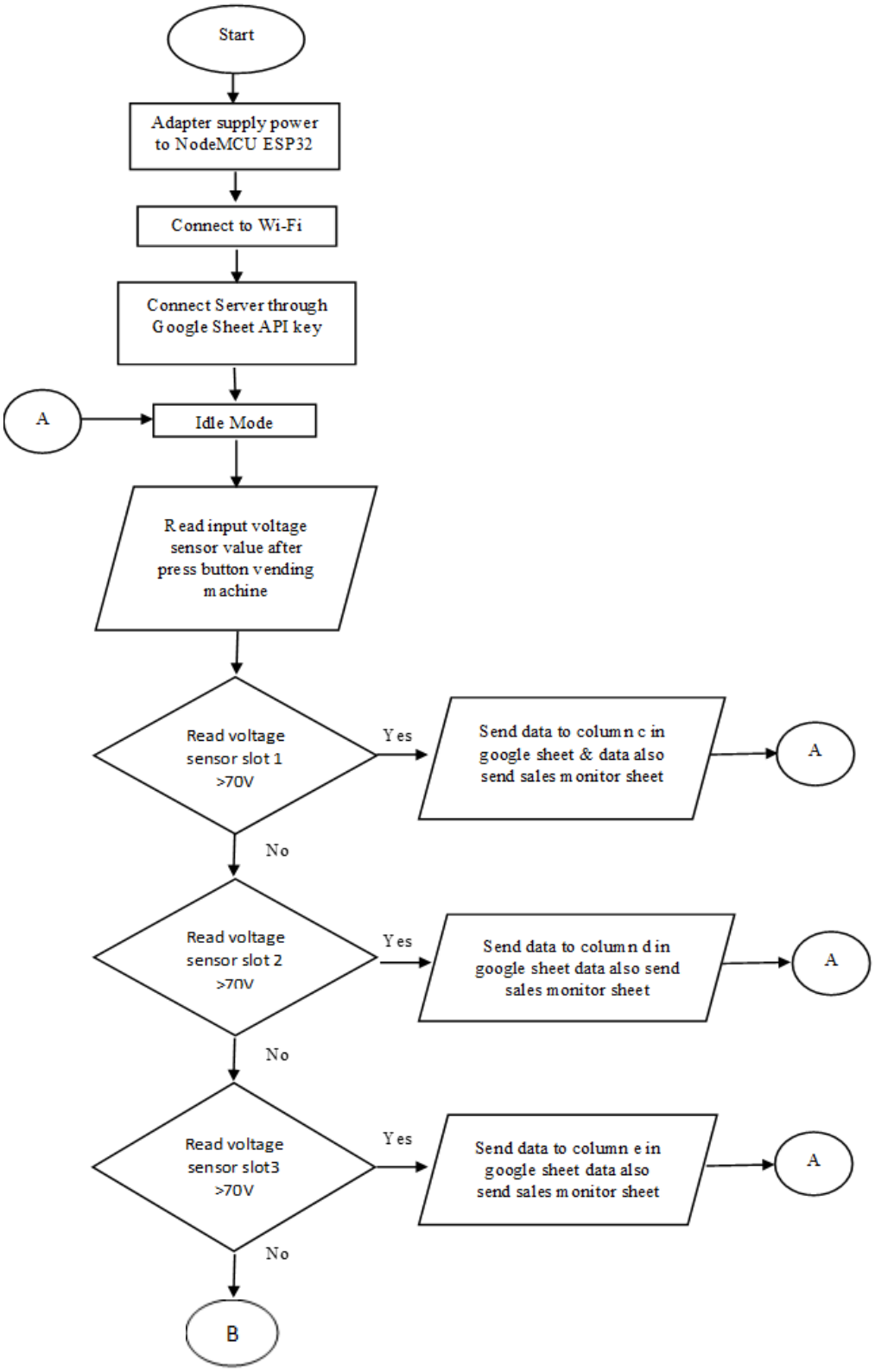


Figure 1: Full block diagram

Figure 1 shows the detail of the system block diagram. NodeMcu ESP 32 is the microcontroller of this whole system. NodeMcu ESP 32 has taking part in a sending data to google sheet via the Wi-Fi feature. The ESP32 microcontroller, which acts as the main control component, is at the system's core [5]. The power supply is connected to the microcontroller. For the part of adc02, the 6 voltage sensors are connected to NodeMcu ESP 32 to send the ADC02 pins. For the part of voltage sensors have 6 sensors connected, the slot can detect by the voltage if the beverage was purchased or not by the two wire was attach to the vending per slot per wire slot was built for vending machine and it was connected to the microcontroller to send the data input. For the notification for sales part system, the Wi-Fi module was built in NodeMcu ESP 32 will give the notification to the google sheet then google sheet about the beverage on the slot was bought. For the part of input of the beverage, the worker of the vending machine needs to input the beverage by manual using the google sheet on the user Mobile Phone. NodeMcu ESP 32 will interface via Wi-Fi feature so that users can monitor the surroundings through the developed website and application.

2.3 System Flowchart



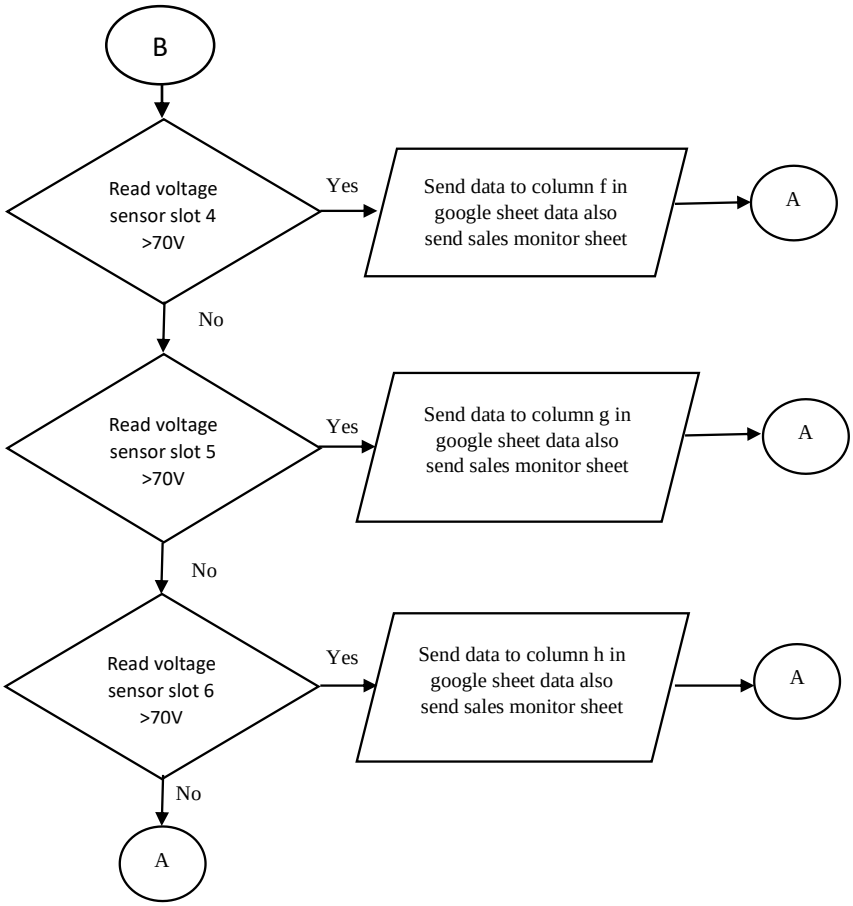


Figure 2: System Flowchart

For the flowchart was shown in Figure 2 above, the program will start with initializing all the components that are connected. For the first task, the interrogator read the voltage sensors. If successfully read the one of the voltage sensors, it will display the on the sales monitor sheet google sheet. For the refilling the beverage task which is entering the input was enter the beverage by the technicians who was refill the beverages in google sheet will have table will display the input and output how many has sold of the beverages. On the other hand, how will know the slot are empty or not from the table from google sheet will have a table which is how many the input was refill and output was sold in the table and if have extra row for the slot are empty or not known by do some subtract from the output of the input and will know how many beverages are left in the slot will display at the google sheet. This system will continuously be running if there is the power that is supplied to the system [11]. If coding is successfully implemented, then can upload the coding to the port of nodemcu ESP32 to develop a sales monitoring vending machine.

3. Results and Discussion

Discussion about the design and implementation of a sales monitoring system for vending machine using IoT, as well as the results obtained. The actual results of the sales beverages on Vending Machine are described in further detail, together with supporting data to substantiate the test results.

3.1 Results

For the hardware testing is conducted to show that the hardware is working successfully. Two different monitor types are being tested: sales monitoring, real time monitoring. Sales monitoring works well for monitoring from google sheet from smartphone after a beverage sold. There is a real time monitoring of the sales for what time and the date to monitor the sales. Figure 3 and 4 below shows the prototype and the complete hardware design of a sales monitoring system for vending machine using IoT.

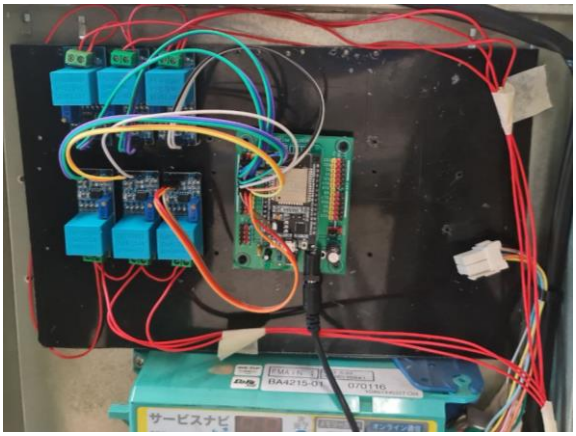


Figure 3: Complete project of sales monitoring system for vending machine using IoT.

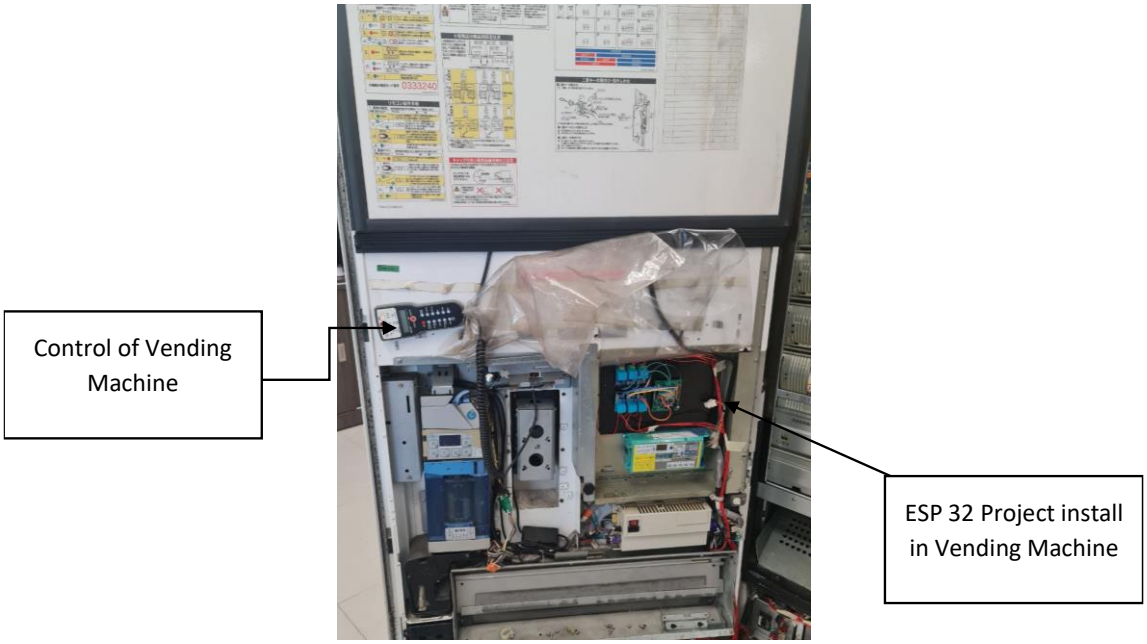


Figure 4: Complete project after install on vending machine

3.2 Discussion

Based on the obtained figures and results are shown from project implement after in vending machine, the wiring was installed as Red Wire same as figure above shown. The controller is use for testing the sales after install the project in vending machine. In this project, the hardware components were tested to ensure their functionality in establishing interfaces between the ESP32 microcontroller and the relay in the PCB on the vending machine. The main objectives of the project are to develop a sales monitoring system for vending machines and a cloud-based database that provides monitoring capabilities to vending machine owners or clients.

To achieve the objective, have test from real time testing, the next step involves integrating a voltage sensor electronic component into the system. This sensor will interact with the microcontroller and confirm beverage sales by detecting voltage spikes generated by the relay on the vending machines PCB. This voltage spike indicates that a sale has occurred. Real-time data and analysis are gathered from testing the system once it is implemented in the vending machine. This data allows for evaluating the system's performance, usability, and accessibility. The investigation primarily focuses on assessing how effectively the project meets its goals and how easy it is for users to access and utilize the system for monitoring sales and inventory in vending machines.

3.3 Validation

Table 1: Table of sample 30 testing sales monitor in google sheet

Sales Monitor Sheet						
Slots	SLOT 1	SLOT 2	SLOT 3	SLOT4	SLOT 5	SLOT 6
In (Actual Beverage in Slot)	30	30	33	30	30	30
Out (Press Manual)	30	29	32	29	30	30
Balance	0	0	0	0	0	0
Error	0	1	1	1	0	0

This result for testing 30 times as buying the beverage as a customer and it appears that the testing involved purchasing beverages from a vending machine that has six different slots, labelled as SLOT 1, SLOT 2, SLOT 3, SLOT 4, SLOT 5, and SLOT 6. During the 30 tests, the voltage sensor was used to detect when voltage spike until 70 voltages above and record sales data afterr pressed the buttons corresponding to the desired beverage slot. However, there was a minor error in the voltage sensor's functionality, specifically in slots 2, 3, and 4. This error caused the sensor to fail to detect sales data in these slots during one or more of the 30 tests. The error found because a was coding more delay in the Arduino IDE. The delay might be causing the voltage sensor to miss or delay the detection of sales data in slots 2, 3, and 4. To resolve this error, have modify the delay in code in the Arduino IDE, specifically for the voltage sensor with the slots 2, 3, and 4. By adjusting the programming logic and removing or reducing any unnecessary delays, have improvement on the sensor's accurately detect sales data in those slots.

	A	B	C	D	E	F	G
1	Sales Monitor Sheet						
2	Slots	SLOT 1	SLOT 2	SLOT 3	SLOT4	SLOT 5	SLOT 6
3	In	58	54	56	55	57	58
4	Out	58	54	56	55	57	58
5	Balance	0	0	0	0	0	0
6							

Figure 5: Figure of Sheet 2 of sample Google Sheet Sales Monitor

Table 2: Table of sample 60 testing sales monitor in google sheet

Sales Monitor in Google Sheet						
Slots	SLOT 1	SLOT 2	SLOT 3	SLOT4	SLOT 5	SLOT 6
In	58	54	56	55	57	58
Out	58	54	56	55	57	58
Balance	0	0	0	0	0	0
Error	0	0	0	0	0	0

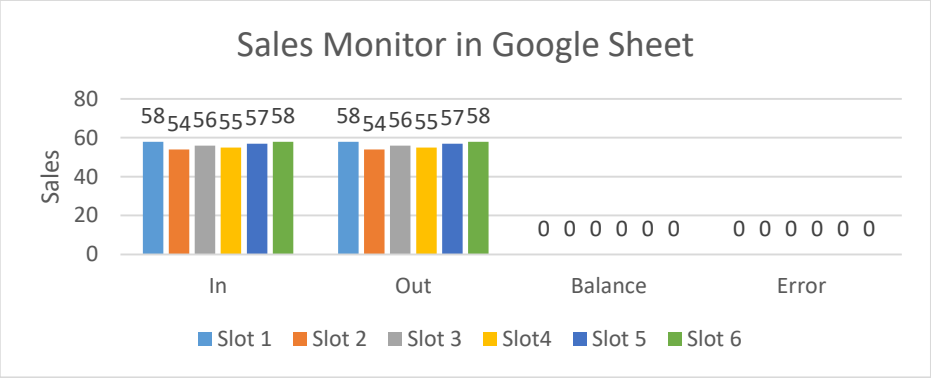


Figure 5: Figure of chart for 60 sales monitors in google sheet

Figure 4, 5 and table 2 explanation of the result is significant at the 60 times testing, where all 6 slots of the experiments was successful compared to the rest. A possible explanation for this might be related to the compulsory Google Sheet function that allows data to be sent periodically. The function is required so that data can be sent in intervals to avoid interference. The timer interval is programmed to send data every 4 second, therefore, when the voltage sensor was read the voltage value above then 70V, so expected as a beverage brought in a slot. If the button presses within 4 second, it's too fast, it isn't able read the sensor's data as quick. Improvements in the success rate can be seen as the delay on the coding value can read accurately. However, for the next purchase after 4 seconds only take as a beverage brought, so in the table above was error for 3 slots because of bought the beverage within 4 second. the table was show for trial for 55 to 60 times beverage sold testing for the beverage from google sheet check whether the coding and hardware are integrated well. So, this experiment was successful without any error found. The time interval must be 4 seconds to another purchase of the beverage.

Table 3: The time interval for the next sales

	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6
First Test	05.33s	05.11s	05.31s	05.41s	05.33s	05.51s
Second Test	05.23s	05.31s	05.27s	05.45s	05.22s	05.13s
Third Test	05.10s	05.21s	05.52s	05.55s	05.30s	05.43s
Fourth Test	05.16s	05.11s	05.51s	05.56s	05.27s	05.31s
Fifth Test	05.21s	05.21s	05.39s	05.31s	05.51s	05.59s

The table 3 discuss about the time interval between each sales compare to previous sales made from vending machine. The time interval was taken from own phone from stopwatch to make sure the state of the time was according to the original. This table has mention about in each test, there seems to be a relatively consistent range of time intervals across the different slots. For instance, in Test 1, Slot 2 consistently records times around 00.05.11s, while slot 4 consistently shows intervals around 00.05.41s. By comparing the results of different tests, we can identify patterns or trends in sales intervals. For instance, Test 3 consistently shows longer time intervals in Slot 4 compared to other slots, suggesting a slower sales rate for that slot across multiple tests.

4. Conclusion

The problem of the vending machine is, there are no telemetry system for the owner to notification if the sales run out of the vending machine. The owner must physically come to the vending machine location to check the sales and refill the beverages. At the same time, the owner must bring along all the available beverages to the location for the refilling. This issue increases the cost of transportation and labour works [10]. Thus, this project is expected to solve the problem. The project consists of system and hardware development which can monitor the beverages in the slot. The voltage sensor will detect the voltage spike from the slot in Vending Machine that spike to 70 voltages will assume as a beverage was sold. The sensor will send the data to the cloud platform Google Sheet for data sales monitoring. Microcontroller ESP32 will send the data of the beverages to the google sheet platform. In addition, the data can be monitored anywhere and anytime. The development of the Internet of Things (IoT) has been considered as the new industrial revolution called 'Industry 4.0'. The internet of thing platform has represented a fundamental concept of all the smart devices that became major parts of smart projects. As technology is getting advanced and complex a vending machine notification system using lot is introduced. Through this project, we can make the society that the engineering field is a wide field.

The hardware parts consist of ESP 32 meanwhile for the software part are Google Sheet and Arduino IDE. In addition, the hardware is developed to detect the less product inside the vending machine and can monitor from anywhere, owner of vending machine to refill it. The monitor is displayed at Sheet 2 of Google Sheet the vending machine owner. Thus, by doing this project can help ease other time because the system helps the vending machine owner easier to know which vending machine to be refilled [6]. Furthermore, objectives and scopes are the guideline for the success implemented for this project.

Acknowledgement

The authors would like to thank the Faculty of Engineering Technology, University Tun Hussein Onn Malaysia for its support.

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