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Designing a Spreadsheet-Based Reverse Vending Machine (RVM) Database Using Arduino Mega 2560 and NodeMCU with App Script Integration

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Abstract
This research discusses the database design for a spreadsheet based payment system using Arduino Mega 2560 and NodeMCU ESP8266 with the help of an app script on a Reverse Vending Machine (RVM) with non-cash rewards. The payment process on the RVM requires admin assistance, so a platform is needed to store data, including the user's mobile phone number and the rewards the user has received. The database allows administrators to check this data to process reward payments to users. Spreadsheet is the platform the author chose for the database because it is easy to use and flexible. Designing a spreadsheet as a database using serial communication between Arduino Mega 2560 and NodeMCU ESP8266. Apart from this, the design also requires the help of the App Script feature to store the user's mobile phone number data and rewards received in a spreadsheet. The design results show that this database is effective and efficient in connecting the RVM with a spreadsheet to store data, thereby reducing the administrative workload in the payment process from the RVM.
Keywords: *Database, Spreadsheet, Reward, Serial Communication, Arduino Mega, NodeMCU*

Abstrak
Penelitian ini membahas tentang perancangan database untuk sistem payment berbasis spreadsheet menggunakan Arduino Mega 2560 dan NodeMCU ESP8266 dengan bantuan app script pada Reverse Vending Machine (RVM) dengan reward non – cash. Proses payment pada Reverse Vending Machine (RVM) ini membutuhkan bantuan admin, sehingga diperlukan suatu platform untuk menyimpan data – data diantaranya adalah nomor handphone pengguna serta reward yang diterima pengguna. Database memungkinkan admin dalam meninjau data – data tersebut untuk dilakukannya proses payment reward kepada pengguna. Spreadsheet adalah platform yang dipilih penulis sebagai database, dikarenakan mudah untuk digunakan dan fleksibel. Perancangan spreadsheet sebagai database menggunakan komunikasi serial antara Arduino Mega 2560 dengan NodeMCU ESP8266. Selain itu, perancangan juga membutuhkan bantuan fitur App Script untuk menyimpan data – data nomor handphone pengguna serta reward yang didapat pada spreadsheet. Hasil perancangan menunjukkan bahwa database ini efektif dan efisien dalam menghubungkan Reverse Vending Machine (RVM) dengan spreadsheet untuk menyimpan data – data sehingga mengurangi beban kerja admin dalam proses payment dari Reverse Vending Machine (RVM).
Kata Kunci: *Database, Spreadsheet, Reward, Komunikasi Serial, Arduino Mega, NodeMCU*

1. Introduction

Reverse Vending Machine (RVM) is a tool designed to simplify waste management while increasing public interest in disposing of waste as a form of participation in maintaining environmental cleanliness [1]. This Reverse Vending Machine (RVM) is equipped with rewards for users [2]. This tool is often installed in strategic locations, such as train stations, shopping centers, parks or recreation areas, residential areas, and university campuses. This tool accepts and identifies the type of waste entered. The kinds of waste included are plastic bottles made from Polyethylene Terephthalate (PET) and cans made from aluminum. When waste is successfully received and identified, users will receive rewards through points, discount vouchers, cash, and non-cash.

Rewards in the form of money on Reverse Vending Machine (RVM) are the best way to increase community participation [3]. This is because cash attracts users interest, encouraging them to collect and recycle waste using a Reverse Vending Machine (RVM). In previous research, coins were used as a method

of providing cash rewards. So, coin rewards are given to users based on categorizing the size and color of the plastic bottle waste that has been successfully entered and received. However, rewards in the form of cash, such as coins, have limits on their value per currency [4]. This causes problems from an economic perspective. Money is usually rounded to the nearest denomination, so it cannot accept the exact monetary value as a reward. As a result, the reward does not provide an exchange value commensurate with the amount of waste that has been entered. Therefore, money in non-cash form is a solution to this problem because it can provide greater freedom in determining the right reward value.

A survey conducted with 30 users also showed that 94.4% of users preferred non-cash rewards. **Fig. 1** shows the results of a reward survey on a Reverse Vending Machine (RVM).

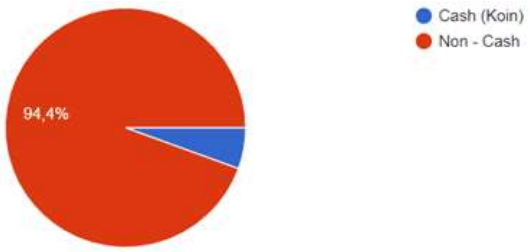

Fig. 1: reward survey results on RVM

With the results of this survey, the author chose to use non-cash rewards in the Reverse Vending Machine (RVM) that was created. E-wallet is a non-cash transaction platform that is flexible and easy to use for giving rewards [5].

Providing rewards in non-cash form requires admin assistance in carrying out transactions [6]. The admin here will also carry out the process and handle any problems with giving rewards to users. To support admin performance in sending rewards to users, a database is needed that stores user data. In previous research, the application was used as a database to store user data. However, the application used in previous research requires a login process in an application that is integrated with a Reverse Vending Machine (RVM) [2]. This causes application creation to require its challenges in designing it. Therefore, the author wants to design a database that is easy to access and easy to use. Spreadsheet is a platform that is easy to use as a database [7]. This research will discuss the design of a spreadsheet-based database that accommodates user data for administrators to provide rewards to users.

2. Material and Methods

a. Hardware

Arduino Mega 2560

Arduino Mega 2560 is a microcontroller board equipped with the Atmega2560 chip. Arduino Mega2560 has 54 input and output pins. These 54 pins are 15 pins as Pulse Width Modulation (PWM) output, 16 pins as analog input, and 14 pins as Universal Asynchronous Receiver Transmitter (UART) [8]. The Arduino Mega 2560 also has large memory, namely 256kb flash memory for storing program code, 8kb Static Random Access Memory (SRAM), and 4kb Electrically Erasable Programmable Read-Only Memory (EEPROM) for storing temporary data and data that must be stored permanently. **Fig. 2** shows the appearance of Arduino Mega 2560.

Fig. 2: Arduino Mega 2560 board [9]

So, author chose Arduino Mega 2560 as a microcontroller to control sensors, actuators and communication modules on Reverse Vending Machines (RVM) because it has many pins and large memory capacity.

NodeMCU ESP8266

NodeMCU ESP8266 is an integrated chip designed to connect microcontrollers to the internet via Wi-Fi. The NodeMCU ESP8266 has powerful internal processing and storage capabilities, making it easy to integrate with certain sensors and applications via GPIO [10]. NodeMCU ESP8266 also supports various communication protocols, such as the Message Queue Telemetry Protocol (MQTT) and the Hypertext Transfer Protocol (HTTP). With this capability, the NodeMCU ESP8266 can interact with web servers and cloud services. **Fig. 3** shows the appearance of NodeMCU ESP8266.

Fig. 3: NodeMCU ESP8266 [11]

So, author chose the NodeMCU ESP8266 as the device that will send data to the database platform via the Hypertext Transfer Protocol (HTTP) protocol with Wi-Fi.

Load Cell Hx711

Load Cell Hx711 is a load cell with a strain gauge type that converts force into an electrical signal whose magnitude is proportional to the force being measured [12]. The installed strain gauge deforms when the load cell deforms under load. The strain gauge is composed of a Wheatstone bridge circuit that series or parallels four resistors [13]. With this change in shape, the electrical resistance of the strain gauge changes. This change in resistance can be measured to determine the weight of the applied load. **Fig. 4** shows the appearance of Load Cell Hx711.

Fig. 4: Load Cell Hx711 [13]

So, author chose a Load Cell Hx711 on a Reverse Vending Machine (RVM) to be used to measure the weight of waste that will be sent to the database.

Inductive Proximity PR30-15DP

Inductive Proximity PR30-15DP is a sensor that can detect the presence of metals, both ferrous and non-ferrous metals. Inductive proximity is composed of a coil or coil that has a ferrite core to produce a high- frequency electromagnetic field [14]. This sensor has two types of configuration, namely, normally open and normally close. This PR30-15DP type sensor has a detection distance of 15mm, or around 1.5cm. **Fig. 5** shows the appearance of Inductive Proximity PR30-15DP.

Fig. 5: Inductive Proximity PR30-15DP

So, author chose Inductive Proximity PR30-15DP on a Reverse Vending Machine (RVM) to be used to detect waste material that will be sent to the database.

Ultrasonic HC-SR04

Ultrasonic HC-SR04 is a sensor that send out ultrasonic waves with a frequency of 40 kHz [15]. Ultrasonic HC-SR04 has two parts, namely the ultrasonic transmitter (trigger) and ultrasonic receiver (echo) [13]. This sensor works using a principle based on the reflection of sound waves. The reflection of ultrasonic sound waves transmitted by the ultrasonic transmitter is captured by the ultrasonic receiver. When ultrasonic waves hit an object, wave reflection will occur. **Fig. 6** shows the appearance of Ultrasonic HC-SR04.

Fig. 6: Ultrasonic HC-SR04

So, author chose Ultrasonic HC-SR04 on a Reverse Vending Machine (RVM) to be used to measure the distance of waste that will be sent to the database.

Light Dependent Resistor (LDR) LM393

Light Dependent Resistor (LDR) is a component whose resistance changes according to light intensity. Light Dependent Resistor (LDR) resistance increases when the light intensity decreases and decreases when the light intensity increases. The Light Dependent Resistor (LDR) resistance value usually reaches 200 kilo ohms in dark conditions and drops to 500 kilo ohms in bright light conditions [16]. **Fig. 7** shows the appearance of Light Dependent Resistor (LDR) LM393.

Fig. 7: LDR LM393 [16]

So, author chose Light Dependent Resistor (LDR) LM3993 on a Reverse Vending Machine (RVM) to be used to measure the light intensity of waste that will be sent to the database.

Liquid Crystal Displays (LCD) I2C 20×4

Liquid Crystal Displays (LCD) is a component that displays text and images as a display medium due to the presence of points of light that form 7 segments [13] [17]. Liquid Crystal Displays (LCD) light sources are formed from white fluorescent lights on the back of liquid crystal devices. When an electric current flows through a liquid crystal electrode, the polarizing effect of the magnetic field causes the electrode to display a certain color. **Fig. 8** shows the appearance of Liquid Crystal Displays (LCD) I2C 20×4.

***Fig. 8**: LCD 12C 20x4* [13]

So, author chose LCD 12C 20×4 on a Reverse Vending Machine (RVM) to be used to display data regarding waste to users.

Keypad 4×4 Matrix Array

The 4×4 Matrix Array keypad is a component used to enter data or commands into electronic systems. This keypad has buttons that can be pressed. When pressing the button, LOW logic will be read on the corresponding line pin. Conversely, when you don't press the button, HIGH logic will be read on the corresponding line [18]. **Fig. 9** shows the appearance of Keypad 4×4 Matrix Array.

Fig. 9: Keypad 4x4 Matrix Array

So, author chose Keypad 4×4 Matrix Array on a Reverse Vending Machine (RVM) to be used to enter the user's cellphone number and the command to be carried out.

b. Software

Arduino IDE

Arduino IDE is software that functions to write programs, then the program will be uploaded to the Arduino board. This IDE can connect and communicate with Genuino and Arduino hardware [19]. **Fig. 10** shows Arduino IDE.

Fig. 10: Arduino IDE

So, author chose Arduino IDE to be used to on a Reverse Vending Machine (RVM) to be used to write programs and upload them to the Arduino Mega 2560 and NodeMCU ESP8266.

Spreadsheet

Spreadsheets are one of the most widely used web-based software for storing, displaying, managing and analyzing data in the form of rows and columns. Spreadsheets can be used as databases that store thousands of rows of data [7]. Apart from data in row form, spreadsheets can also visualize data through graphs and tables. Spreadsheets can process data in real-time and can be integrated into other applications. **Fig. 11** shows Google Spreadsheet.

Fig. 11: Google Spreadsheet

In the Reverse Vending Machine (RVM), this spreadsheet is used as a database to store variable data from installed sensors.

App Script

App Script is a development platform owned by Google Apps with a JavaScript-based cloud programming language that is used to automate functions in Google services such as Gmail, Sheets, and others [20]. App Script can also perform custom user interface creation and integrate third-party services. By using application scripts, projects can carry out data processing, sending email notifications, and updating information in real-time. **Fig. 12** shows App Script.

Fig. 12: App Script

In the Reverse Vending Machine (RVM), this app script will be integrated with a spreadsheet to display the required data variables.

c. System Design

Block Diagram

In the Reverse Vending Machine (RVM) the author uses four sensors as input. This sensor consists of a load cell to measure the weight of the waste, proximity to detect the waste material, ultrasonic to measure the distance of the waste, and a light dependent resistor (LDR) to measure the light intensity of the waste. The resulting data from this sensor is sent to the microcontroller in the processing section. Arduino Mega 2560 is the main microcontroller as a processing center that collects, processes and transmits data. NodeMCU ESP8266 is a Wi-Fi module as a cloud-based service sender. Data on the Arduino Mega 2560 is sent to the NodeMCU ESP8266 in the appropriate format. NodeMCU ESP8266 sends data to App Script using an internet connection. Data from the Arduino Mega 2560 is displayed on the LCD as the first output and Google Spreadsheet as the second output via application scripts. **Fig. 13** shows the block diagram of the database system.

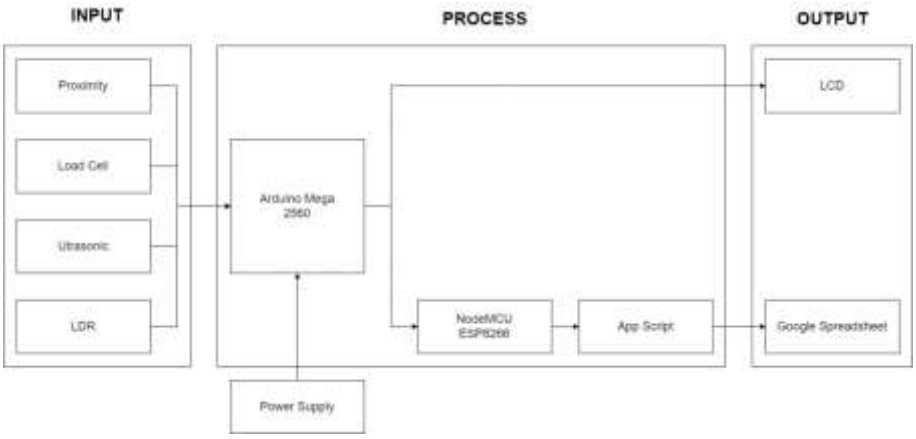

Fig. 13: Block diagram

Schematic Diagram

Serial communication is sending data per bit, where data is sent sequentially via cable or wireless [21]. In the Reverse Vending Machine (RVM) serial communication is carried out between the Arduino Mega 2560 and the NodeMCU ESP8266. The TX0 (Transmitter) pin of the Arduino Mega 2560 is connected to pin D6 (GPIO12) of the NodeMCU ESP8266 and the RX0 (Receiver) pin of the Arduino Mega 2560 is connected to pin D7 (GPIO13) of the NodeMCU ESP8266. The required sensors, such as load cell, proximity, ultrasonic, and light dependent resistor are connected to the Arduino Mega 2560 for processing. **Fig. 14** shows a schematic diagram of serial communication between Arduino Mega 2560 and NodeMCU ESP8266.

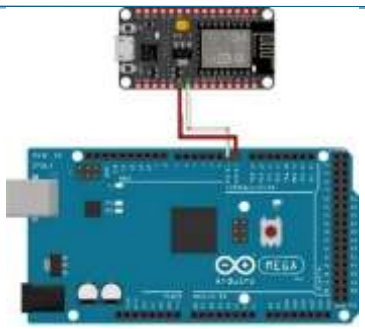

Fig. 14: Serial communication Arduino Mega and NodeMCU schematic diagram

Table 1 shows the connection of each pin between the Arduino Mega 2560 and NodeMCU ESP8266 which will be serialized.

Table 1: Arduino and NodeMCU connections

Arduino Mega 2560	NodeMCU ESP8266
Tx0	D6
Rx0	D7
3.3V	VCC
GND	GND

Fig. 15 shows a schematic diagram of the components from which data will be taken using serial communication between the Arduino Mega 2560 and the NodeMCU ESP8266.

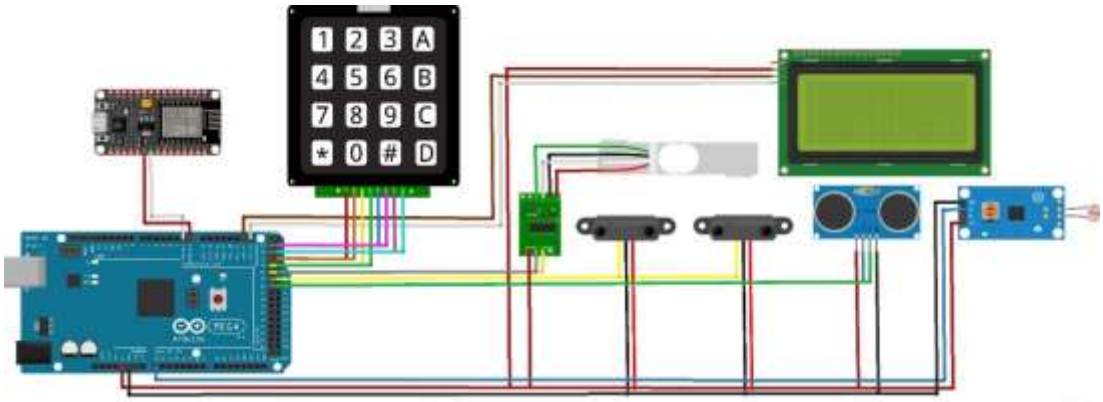

Fig. 15: Components schematic diagram

Table 2 shows the connection of each pin between the Arduino Mega 2560 and all the components for the Reverse Vending Machine (RVM).

Table 2: Arduino and all components connections

Component	Component Pin	Arduino Mega 2560
NodeMCU ESP8266	D6	Tx0
	D7	Rx0
	VCC	3.3V
	GND	GND
Keypad	R1	26
	R2	27
	R3	28
	R4	29
	C1	22
	C2	23
	C3	24
	C4	25

Component	Component Pin	Arduino Mega 2560
LCD	SDA	SDA
	SCL	SCL
	VCC	5V
	GND	GND
Load Cell	DT	30
	SCK	31
	VCC	5V
	GND	GND
Proximity 1	Out	32
	VCC	5V
	GND	GND
Proximity 2	Out	33
	VCC	5V
	GND	GND
Ultrasonic	Trig	34
	Echo	35
	VCC	5V
	GND	GND
LDR	Out	A0
	VCC	5V
	GND	GND

d. Serial Communication Design

The first serial communication is carried out by sending data in variable form via a serial connection from the Arduino to the NodeMCU. This data in the form of variables is combined into a string, namely the string 'datakirim'. **Table 3** shows all the data stored in the string ‘datakirim’.

Table 3: Data on string ‘datakirim’

String (datakirim)	phoneNumber
	berat
	proximityValue1
	proximityValue2
	ultrasonicDistance
	ldrValue
	reward

Second, receiving data by the NodeMCU from Arduino via a serial connection. The data received is 'parsed' or read the data one by one and then separated according to the data to be sent [22]. The string will be separated again into individual values using the '#' separator. Third, the data that has been parsed and stored in nodemcu will be sent to spreadsheet via a Wi-Fi connection. Apart from that, an HTTPS connection to Google App Script is also prepared. The URL is used to send data which is converted into a string, so that the data can be sent to spreadsheet. **Fig. 16** shows serial communication flow diagram between Arduino and NodeMCU in sending data.

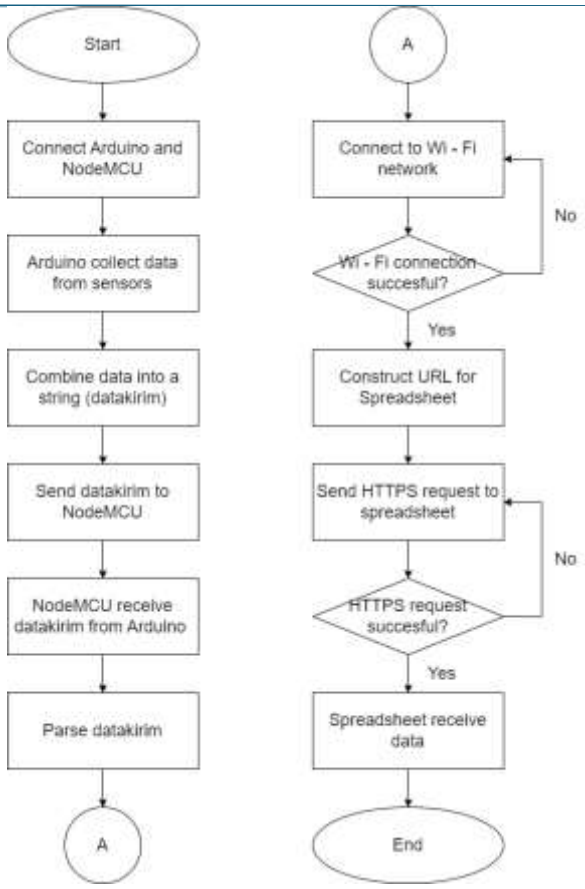

Fig. 156 Flowchart serial communication

e. Spreadsheet Design

In Reverse Vending Machine (RVM), a spreadsheet is a place to store data from components that have been sent via serial communication. This spreadsheet is designed by giving names to each column sequentially according to the order in which data is sent in serial communication. The data that the spreadsheet will receive is Date, Time, Phone, Load Cell, Proximity 1, Proximity 2, Ultrasonic, LDR, and Reward. Any data received has an appropriate format, such as a precise date and time format, as well as a numeric format for sensor values. **Fig. 17** shows the design of a spreadsheet as a database storing data.

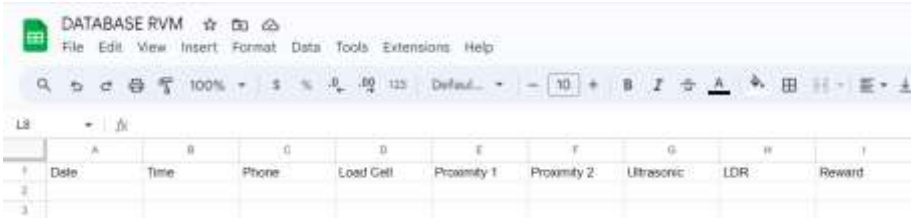

Fig. 167: Spreadsheet design

f. App Script Design

To display values on a spreadsheet based on the previous spreadsheet design, an app script that is integrated with Arduino and NodeMCU will be used. The app script design starts from taking the current date which is then saved in a spreadsheet column. Then, the type of data that will be processed will be determined. So, the data obtained from aduino and nodemcu will automatically be saved in a spreadsheet column that has been designed with time added to that column. **Fig. 18** shows the flowchart of the app script.

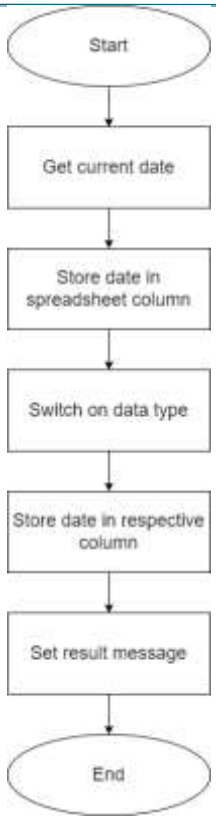

Fig. 178: App script flowchart

Table 4 shows the type of data that is processed to be sent to the spreadsheet column on the Reverse Vending Machine (RVM).

Table 4: Data type

Column	Data Type	Spreadsheet Column Index
rowData[0]	Curr_Date	0 (First column)
rowData[2]	phone	2 (column C)
rowData[3]	loadcell	3 (column D)
rowData[4]	proximity1	4 (column E)
rowData[5]	proximity2	5 (column F)
rowData[6]	ultrasonic	6 (column G)
rowData[7]	ldr	7 (column H)
rowData[8]	reward	8 (column I)

g. Flowchart

This flowchart explains the data sending process starting from port initialization, serial communication, IP address, app script, and spreadsheet. After the Arduino Mega is connected to the NodeMCU, the data will be taken by the Arduino Mega. If the data is successfully retrieved, the data will be sent to the nodemcu and also displayed on the LCD. If the data is successfully sent to the nodemcu, the nodemcu will be connected to the internet. If the nodemcu is successfully connected to the internet, the data will be sent to a spreadsheet. If the data is successfully sent to the spreadsheet, the data will be displayed on the spreadsheet according to the original data. **Fig. 19** shows the flowchart of the system.

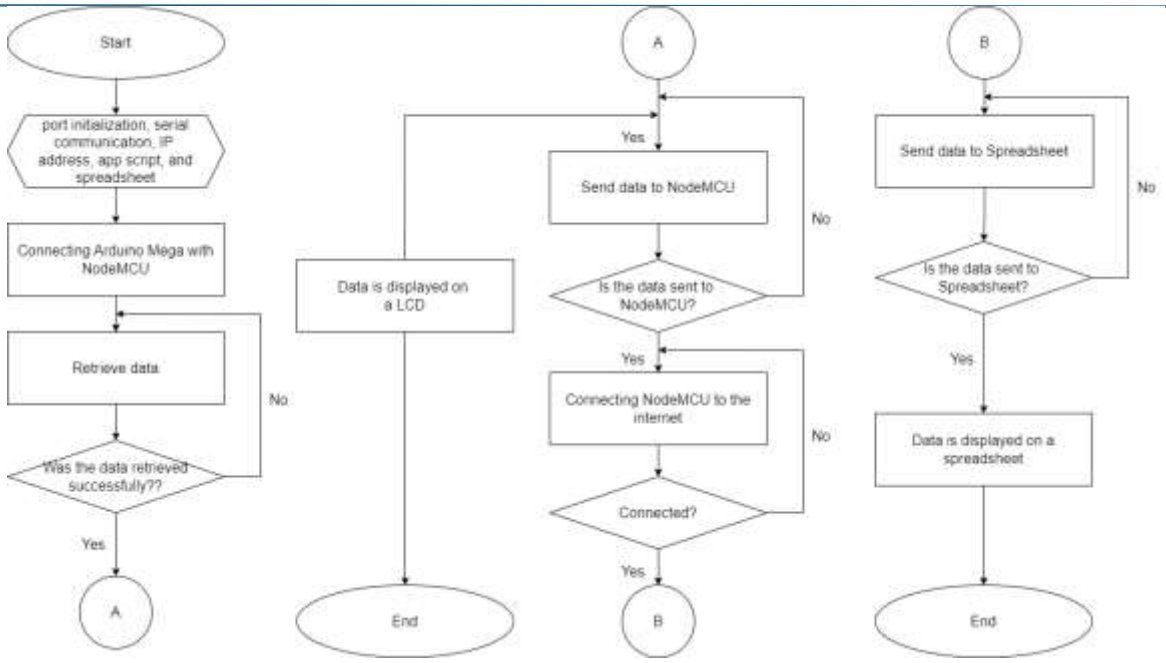

Fig. 189: Flowchart

3. Results and Discussion

The tests carried out will show how capable the Reverse Vending Machine (RVM) system is in collecting and sending data precisely from the Arduino Mega 2560 to a spreadsheet via NodeMCU. Testing will be carried out in two stages, namely testing the accuracy of the data sent and recorded on the spreadsheet, as well as testing the time required to update the spreadsheet after the data is saved. **Fig.20** shows the wiring to perform both tests resulting from the implementation of the schematic diagram that has been designed.

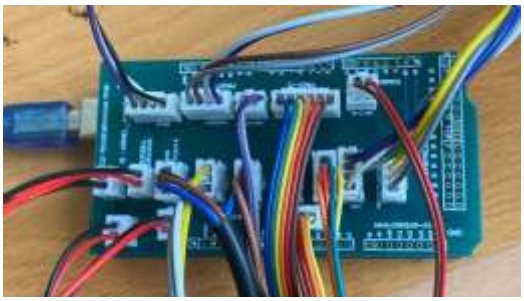

Fig.20: Wiring components

Sensor measurement tests were carried out with various samples of canned and plastic bottle waste which had different criteria. **Fig. 21** shows the sensor measurement process on canned waste.

Fig. 191: Testing prototype

The serial monitor will display cellphone number data entered by the user, sensor data such as load cell, proximity, ultrasonic, and LDR from the trash entered and the rewards received by the user. **Table 5** shows data on the serial monitor

Table 5: Data on Arduino

Attempt	Data on Arduino
1	09:55:30.419 -> Tared! 09:55:33.402 -> 089543677542#25.97#0#1#22.41#376#44
2	09:56:31.601 -> Tared! 09:56:34.567 -> 089543677542#15.50#0#0#17.94#231#57
3	09:57:26.982 -> Tared! 09:57:29.967 -> 089543677542#7.87#0#0#14.47#335#57
4	09:59:12.093 -> Tared! 09:59:15.061 -> 089543677542#10.78#0#0#20.44#204#55
5	10:00:24.873 -> Tared! 10:00:27.858 -> 089543677542#7.69#0#0#14.76#306#57
6	10:06:10.192 -> Tared!
7	10:07:10.940 -> Tared! 10:07:13.926 -> 089543677542#19.74#1#0#28.72#357#44
8	10:08:03.755 -> Tared! 10:08:06.745 -> 089543677542#16.47#0#1#21.94#359#44
9	10:13:30.409 -> Tared! 10:13:33.403 -> 089543677542#11.21#0#0#29.25#214#55
10	10:16:04.341 -> Tared! 10:16:07.309 -> 089543677542#29.16#0#1#16.67#222#44

On the Liquid Crystal Display (LCD), the user's cellphone number will be displayed and the data measured by the sensor will be displayed in the form of waste categorization and rewards obtained. **Fig. 22** shows the data displayed by the LCD.

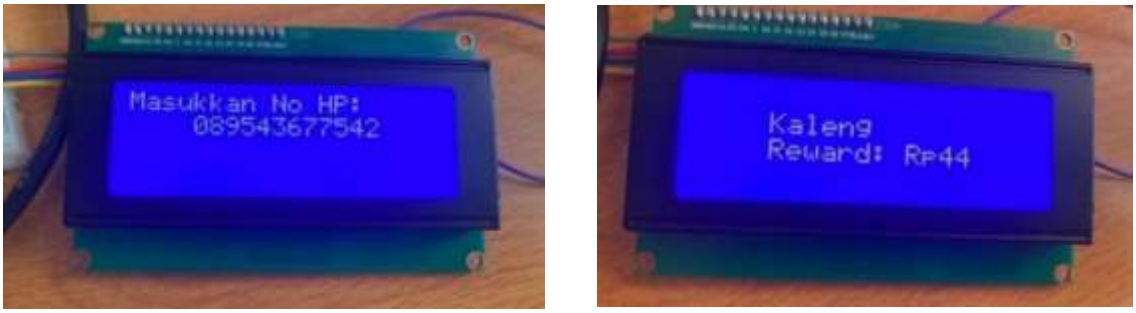

Fig. 202: Display data on LCD

The cellphone number and reward data displayed on the Liquid Crystal Display (LCD) corresponds to what was sent on the spreadsheet. This shows measured by components and sensors via serial communication between the Arduino Mega 2560 and the NodeMCU ESP8266. **Fig. 23** shows the spreadsheet stored data.

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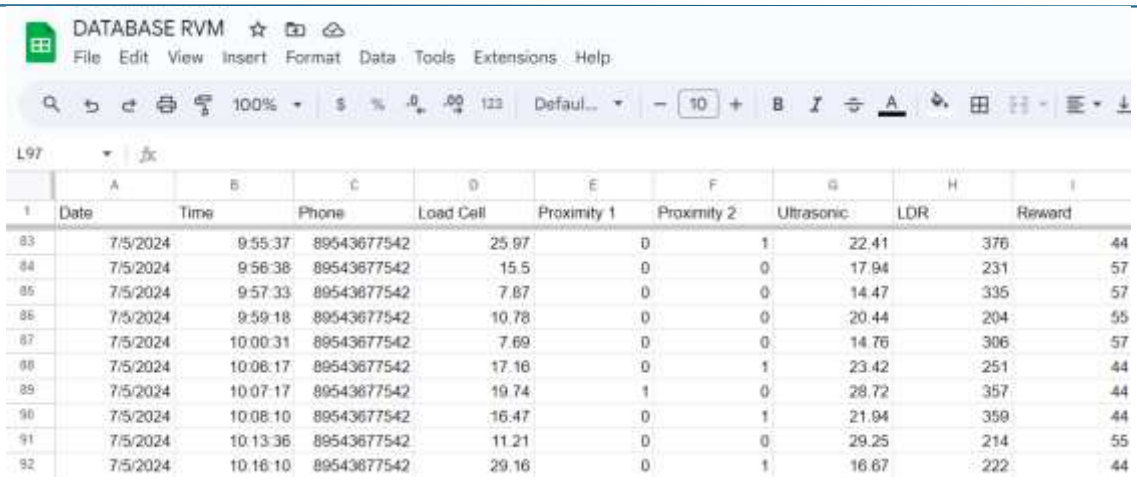

	A	B	C	D	E	F	G	H	I
1	Date	Time	Phone	Load Cell	Proximity 1	Proximity 2	Ultrasonic	LDR	Reward
83	7/5/2024	9:55:37	89543677542	25.97	0	1	22.41	376	44
84	7/5/2024	9:56:38	89543677542	15.5	0	0	17.94	231	57
85	7/5/2024	9:57:33	89543677542	7.87	0	0	14.47	335	57
86	7/5/2024	9:59:18	89543677542	10.78	0	0	20.44	204	55
87	7/5/2024	10:00:31	89543677542	7.69	0	0	14.76	306	57
88	7/5/2024	10:06:17	89543677542	17.16	0	1	23.42	251	44
89	7/5/2024	10:07:17	89543677542	19.74	1	0	28.72	357	44
90	7/5/2024	10:08:10	89543677542	16.47	0	1	21.94	359	44
91	7/5/2024	10:13:36	89543677542	11.21	0	0	29.25	214	55
92	7/5/2024	10:16:10	89543677542	29.16	0	1	16.67	222	44

Fig. 213. Display data on spreadsheet

The results of the experiment were carried out by inserting 10 pieces of waste into the Reverse Vending Machine (RVM) which aims to see whether the data sent from the Arduino Mega 2560 to the spreadsheet can be sent and recorded correctly. **Table 6** shows the test results data recorded in a spreadsheet.

Table 6: Result data recorded in spreadsheet

Date	Time	Phone	Load Cell	Proximity 1	Proximity 2	Ultrasonic	LDR	Reward
7/05/2024	9:55:37	89543677542	25.97	0	1	22.41	376	44
7/05/2024	9:56:38	89543677542	15.5	0	0	17.94	231	57
7/05/2024	9:57:33	89543677542	7.87	0	0	14.47	335	57
7/05/2024	9:59:18	89543677542	10.78	0	0	20.44	204	55
7/05/2024	10:00:31	89543677542	7.69	0	0	14.76	306	57
7/05/2024	10:06:17	89543677542	17.16	0	1	23.42	251	44
7/05/2024	10:07:17	89543677542	19.74	1	0	28.72	357	44
7/05/2024	10:08:10	89543677542	16.47	0	1	21.94	359	44
7/05/2024	10:13:36	89543677542	11.21	0	0	29.25	214	55
7/05/2024	10:16:10	89543677542	29.16	0	1	16.67	222	44

The test results show that from 10 attempts to put waste into the Reverse Vending Machine (RVM) there was 100% success in sending data from the Arduino Mega 2560 to a spreadsheet via the NodeMCU ESP8266. This shows that with different sensor values the waste input results on the Reverse Vending Machine (RVM) can produce results according to those recorded on the spreadsheet.

Based on the test results of sending data from the Arduino Mega 2560 to a spreadsheet via NodeMCU, a response time test was carried out which aims to measure how quickly the data sent from the Arduino Mega 2560 can be received and recorded on the spreadsheet. **Table 7** shows response time data in sending data.

Table 7: Result data response time

Test	Time Sent (Arduino)	Time Received (Spreadsheet)	Response Time
1	09:55:33	09:56:38	65 seconds
2	09:56:34	09:57:33	99 seconds
3	09:57:29	09:57:33	4 seconds
4	09:59:15	09:59:18	3 seconds
5	10:00:27	10:00:31	3 seconds
6	10:06:13	10:06:17	4 seconds
7	10:07:13	10:07:17	4 seconds
8	10:08:06	10:08:10	4 seconds
9	10:13:33	10:13:36	3 seconds
10	10:16:07	10:16:10	3 seconds

The test above shows that from 10 attempts there is a consistently good and fast response time with a time range of 3 – 4 seconds. However, experiments 1 and 2 show a much longer response time. This may be caused by network/communication problems when testing. If the calculated percentage of response time is less than 10 seconds, then:

$$Percentage = \frac{Response\ time\ attempts < 10\ seconds}{Total\ attempts}$$

$$Percentage = \left(\frac{8}{10}\right) \times 100\% = 80\%$$

So, from 10 attempts there was 80% success in sending data with a fast response time of under 10 seconds.

4. Conclusion

This research succeeded in designing a spreadsheet-based database for a payment system on a Reverse Vending Machine (RVM). This system uses serial communication between Arduino Mega 2560 and NodeMCU ESP8266, as well as App Script assistance for Spreadsheets. This system stores data measured by sensors, such as load cells to measure the weight of waste, proximity to detect waste material, ultrasonics to measure the distance of waste, and Light Dependent Resistro (LDR) to measure the light intensity of waste. Apart from that, the system also stores data on the user's cellphone number and the rewards received. This is to make it easier for Reverse Vending Machine (RVM) admins to process payments to users. The results of this research show 100% success in sending and storing data in the database and 80% success in response time sending data under 10 seconds.

5. Abbreviations

RVM	Reverse Vending Machine
PET	Polyethylene Terephthalate
HTTP	Hypertext Transfer Protocol
MQTT	Message Queue Telemetry Protocol
LDR	Light Dependent Resistor
LCD	Liquid Crystal Displays

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