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Smart Airtime Vending Machine: A Case of Nyamasheke District, Nyabitekeri Sector

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ABSTRACT

Purpose: The aim of this paper was undertaking modern technology by designing and implementing a smart airtime vending machine known as a self-service airtime vendor machine that will come as an additional method apart from the current airtime selling and buying methods which are mobile money, banking, airtime agent that involves theft of money and airtime loading mistakes and errors. It will help rural citizens to buy airtime using a coin where a customer has to enter the mobile number using a keypad then inset coin in airtime vending machine, and automatically the machine dispenses the airtime equivalent to the amount inserted.

Methodology: The methodology used consists of an IoT system where the customer will access the vending machine by inserting it into a coin to buy airtime. This research consists of three main parts, the first part is the interconnection of IoT hardware components that build the entire circuit and are linked to the cloud via GPRS/GSM communication technology, this part involves sensing components, data processing components, and actuators components. The second part consists of coding using Arduino IDE that makes IoT system hardware operational and the last part is data processing and analytics using python programming and regression as a machine learning technique. The system monitoring is done through wireless radio, the cloud data storage is secured and can be easily accessible by authorized users via a web interface. The battery is used for powering the system and the solar panel for recharging the battery. All transaction data are recorded and given date returns the day type between working days, weekends, and the session of the day.

Findings: The results of the research include an IoT system that is developed and implemented to help both airtime agents and customers to sell and buy airtime using coin-based self-service airtime vending machine and the model that analyse machine transaction data using Python programming and regression as a machine learning technique.

Unique contribution to practice: It improved the airtime vending system's efficiency and sustainable management of airtime agent. It facilitates safe selling and buying of airtime across the country especially in rural areas where getting airtime seemed to be a problem. The Internet is also used for linking cloud platform and application users.it indicates that the vending machine can provide positive impact in society including self-service of airtime to citizens from nearby vendors, the distribution of machines country wide can increase employability.

Keywords: IoT, Air time, Vending Machine, Machine Learning

INTRODUCTION

Several merchandising machines dispense snacks, biscuits, and beverages while money is inserted according to pre-programmed system but nowadays vending machines offer many extra things to customers including using machine learning mechanisms. As these machines are connected with IoT networks, they're called clever vending machines. Using such smart merchandising machines, customers should purchase clothes, items, vegetation, luxurious vehicles, and so forth. IoT-primarily based machines help stores promote their merchandise across the clock and provide more comfort to purchasers. Vending machines are established on street corners, railway stations, airports, outdoor offices, and so forth. The machines include virtual presentations, which offer interesting reviews to customers (Karthika et al., 2019)

Smart merchandising machines are incredible examples of the impact of the Internet of Things (IoT) on revenue streams and commercial business enterprise fashions. The use of IoT in vending machine improved protection, individual customization, smart payments, and normal monitoring of inventory and a lot of opportunities for new products on the market. A tremendous shift, almost 100 years after merchandising machines were first deployed, conventional vending machines have superior technology to embody more virtual talents, turning them from dumb terminals into smart, linked gadgets (Plaha & Singh, 2012). New reference layout for sensible merchandising offers a smooth manner to retrofit conventional vending machines into net-related machines. Brands and machine operators can take advantage of recent company possibilities, cloud services, and facts analytics through a suite of associated products and packages.

Internet of Things contributes to vending gadget industry to enhance financial returns with improved revenues, improved profitability, and a higher financial satisfaction in digital content material cloth delivery, Intelligent software program solutions permit the shipping of virtual content material to the most display screen of a vending tool, with extra impact vending machines can act as billboards, imparting custom content, inclusive of promotions, movies, video games, and TV classified ads on a unit's touch display. By putting these machines at immoderate-web page site visitors' net websites, like stadiums and theatres, businesses can create an immediate connection with consumers which turned in turn improves living of people. This enables manufacturers reach unique audiences proper away and allows the brand to remotely manipulate messages in real-time and launch custom designed content material dynamically. This additionally helps generate new assets of content fabric and marketing revenues that might be allotted some of the system operators, the venues, or any entity that controls the power where the machines are stationed (Patel et al., 2016).

In inventory management, Vending Machines use sensors and built-in intelligence and this can make the proper stock selections, Connected structures allow manufacturers and distributors from the shipments to distribution centres and vending machines, in addition to accumulate client records from machines to screen utilization for correct consumable resupply, track income traits by means of geography and time of year, and remotely troubleshoot system issues. The software program combines the carrier and stock alerts with income facts so agencies can dispatch their provider humans to the most profitable machines first.

The tool additionally makes smart inventory alternatives primarily based on the facts it has accumulated from the vending system and all of the others owned with the aid of way of this commercial enterprise organisation, similarly to information from outside property. For example, honestly because it's low on ice cream could now not mean the device will place orders for greater ice cream not if the weather is meant to be bloodless for the subsequent numerous days. It additionally takes into consideration other elements, which include

popularity, while putting stock levels, so the right quantity of each snack is added to the truck for transport each day.

Research Gap

After analysing the vending machine market especially in Rwanda it appears that vending machines have been used in many different businesses such as buying, public shipping, banking, bars and resorts, and others to supply beverages, snacks, sweets and candies, tobacco, and others. However it's far clean that the shortage of merchandising machines that promote airtime is identified and these merchandising machines and have not been used everywhere in the region, and that seems like a large gap in this region of business being made the usage of vending machines, this project is to bridge this gap by means of layout and enforce a self-service and airtime value-effective coin based and particularly for rural citizen.

This vending machine can be placed in public areas like markets, schools, construction sites, mining sites, village centres, and other places where getting airtime seems to be difficult. Finally, the data generated by vending machine will be stored on a remote cloud server and will be analysed using regression as machine learning algorithm to predict the amount of money to be dispensed by the vending machine based on day sessions and vending machine location.

LITERATURE REVIEW

Nowadays, various research has been done about the vending machines to advance or renovate the vending machine system. A real-time vending machine and a cost affordable communications solution based on open innovation technology is designed (Dua, 2014). Wi-Fi and GPRS are introduced inside the vending machine with the goal that the information about the stock level can be stored in a database which can help make informed decision or refilling the machine with new stocks. Likewise, Mealy Model of "Finite State Machine strategy" is utilized to structure and implement an automated beverage vending machine (Husain, 2017).

Amin and Rahman (2018) Proposed smart milk merchandising system thus inside the milk canters there can be a massive queue to gather milk because milk desires to be measured and additionally has to gather the cash. So, to forestall the equipped time in the queue and paying cash via hand, the RFID reader can be applied in milk canters. To get rid of the human involvement a card device is used for merchandising or for selling out the milk. The card gadget consists of the RFID which encompass RFID reader and RFID tags that may help customers at the milk canters (Ramzan et al., 2017). Using this tags milk may be vended without human interaction or involvement.

Manmohan et al. (2019) furnished a gadget a clever merchandising system includes a sensor and actuator network, which incorporates of a gateway, environmental sensors, and controllers. A gateway turns into an extension among the community and a software taking walks on a cell phone via Bluetooth. The gateway gets some messages associated with the environmental situations of the machine from the sensors. Those messages are sent to the software. In addition, the gateway sends manipulate messages inclusive of the customer's desire on the taste of espresso to the controllers. They concluded that the proposed device is format to provide fast response serving, to solve real time problem. The improvement of the overall performance and design value changed into considered (Sibanda et al., 2020). Using this device design, the overall performance of Vending system can be without problems extra superb for masses applications. Complexity discounts that incorporate with the time and place boom the performance of the overall gadget utilized in vending machine. Also, we are going registered

database of the purchaser through reducing human interplay. The destiny paintings of this vending machine are to enhancing it by using which include toll unfastened variety in case of any failure.

In addition, it is recommended that the system layout a good way to get hold of ATM playing card as opposed to paper money. Also, improving efficiency and complexity discount of the device may be viable as a way to transform the Vending gadget to a wise method (Vijayaragavan et al., 2020). Jadh et al. (2017) proposed intelligent coffee vending device by using RFID. It includes Automatic ordinary espresso merchandising device such as coffee powder or coffee beans, sugar, and milk powder saved in chamber and also includes the recent water chamber where in the water is heated. After giving command through a switch, the gadget add that particular quantity of components in the heat water. Then it is delivered within the cup. The controlling mechanism like heating is executed by using microcontroller. This process makes a speciality of automated espresso merchandising device by the use of Arduino controller and RFID.

Yang et al. (2017) put forward the design of the coffee vending machines based on the technology of internet of things and its remote management system, which is focusing on current problems occurring in existing system such as difficulties in analysing data and really high cost of administration. This design not only makes the sales and supply information available; it can survey this information into cloud corner through GPRS as well.

According to Rahul et al. (2017) proposed smart coffee vending machine using RFID. Automatic regular coffee vending machine including coffee powder or coffee beans, sugar, and milk powder stored in chamber. It also includes the hot water chamber where the water is heated. After giving command through a switch the machine add that specific amount of ingredients in the hot water. And then it gets delivered in the cup. The controlling mechanism like heating is done by the use of microcontroller (Gruber et al., 2005).This project focuses on automatic coffee vending machine using the Arduino controller and RFID technology which is used to control the consumption of product and also reduce the waste of product in low budget and also gives the historical data in EPROM.

Nowadays, automated machines are in demand for making numerous activities not only easier, but also more efficient (Nilani & Tharaga, 2020). These machines require minimal human intervention to carry out the work. The machine has numerous inputs and outputs to provide service to customers. The Automatic machine operates based on electronics engineering, mechanical engineering, and electrical engineering, which is a collectivity termed Mechatronics. People spend more time buying things in supermarkets as the market is crowded. Hence, it disappoints the customers and it leads to losing income to the vendors (Sibanda et al., 2020).

Normally people touch the things (mostly vegetables) to identify their quality. At that time, they can be affected by infectious diseases. Low hygiene and quality of most of the things are finally needed more workers to maintain the quality. Therefore, higher salary which needs to be paid to workers, and there is security issue as most of the customers use the cash payment method. As a result, design of the vending machine is the best solution to avoid these problems. The vending machine is one of these automated machines which supply needed things to the customer.

According to the study (Alharbe & Akbari, 2013) authors have defined a concept of automatic fee price ticket VM with the resource of the use of the sensor, RFID, and ZigBee approach. This approach gave secure environments due to the fact every transaction is monitored and

stored for all future identification. The devoted VM used for purchasing tickets has LCD that is the one of the smart capabilities in the modern-day VM. Through this LCD, the humans can see the data of the journey time and destination that humans have deliberate to go to.

METHODOLOGY

This part includes the studies method of the dissertation. In more detail, in this component the writer outlines the research technique, the research method, the studies approach, the strategies of statistics collection, the selection of the pattern, the research manner, the form of statistics assessment, the chapter concludes with an outline of the ethical troubles and the studies limitations of the task, approach (Goddard & Melville,2004).

The smart airtime vending machine consists of three main parts. The first is IoT hardware component that build the entire circuit. This part involves sensing components, data processing component and actuators components. The second part consists of programming to make system hardware operational. The last part is data processing and analytics, which will be done using Python programming and regression as machine leaning technique and will be visualized on graph.

System Block Diagram

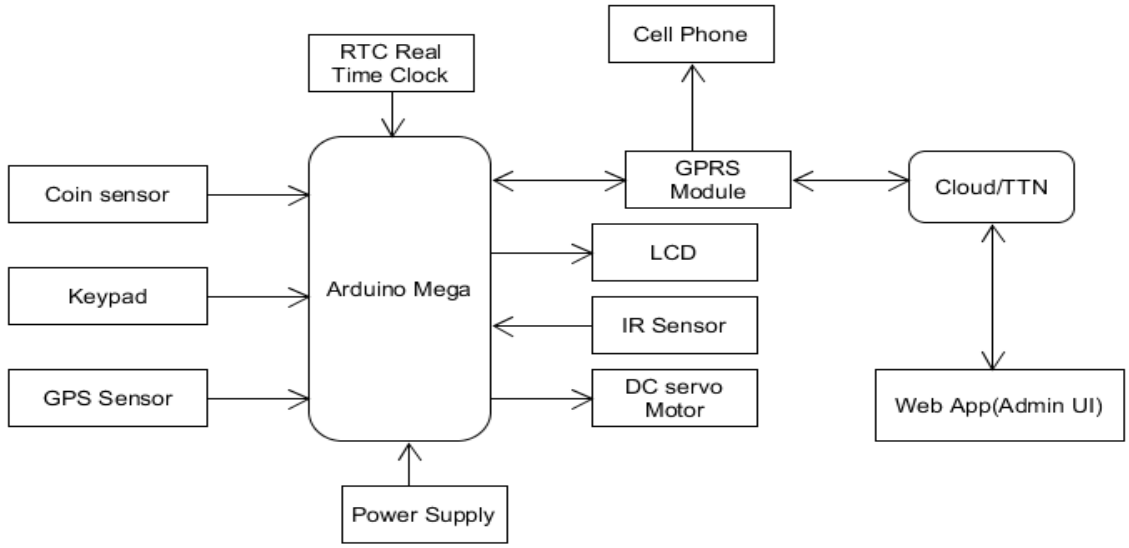

Figure 1: System block diagram

Source: Researchers' data

Technically the system design combines several technologies where different modules were connected to achieve the research goals. The Arduino ATmega 328 which has 32 KB ISP flash memory, 8 bits pressor in 28 pin DIP package,14 digital input and output pin and 6 analog inputs, 5 volts as power supply, 2 KB of SRAM is used as control unit. The multi-coin selector CH-923/924/925/926/928 which assist six extraordinary cash is used to just accept or reject coins based on those are programmed too (Kocurek et al.,2014), The Motion Detection – IR Proximity Sensor that is used to stumble on the vending gadget's clients (Benezeth et al.,2008), SIM800 GSM/GPRS module used as communication module to link the vending machine with the cloud remote server[48], The NEO-6MV2 GPS Module used to locate the vending machine (Lin et al.,2001), The DC Servo motor used to return the coins in case the transaction is cancelled,1.3 Inch LCD white colour 28×64 dot matrix display module with SPI Interface used as vending machine display.

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The 4 x four matrix keypad typically is used as input (Bihlmayr, 2007) and an actual-time clock (RTC) as a clock that keeps song of the modern-day time and that may be used so one can program movements at a certain time. The device can pinnacle up airtime based on coins inserted into the merchandising machine and ship notification SMS to the consumer's cellular wide variety. The customers can engage with the device thru the web and keep its information to the cloud at the server-aspect.

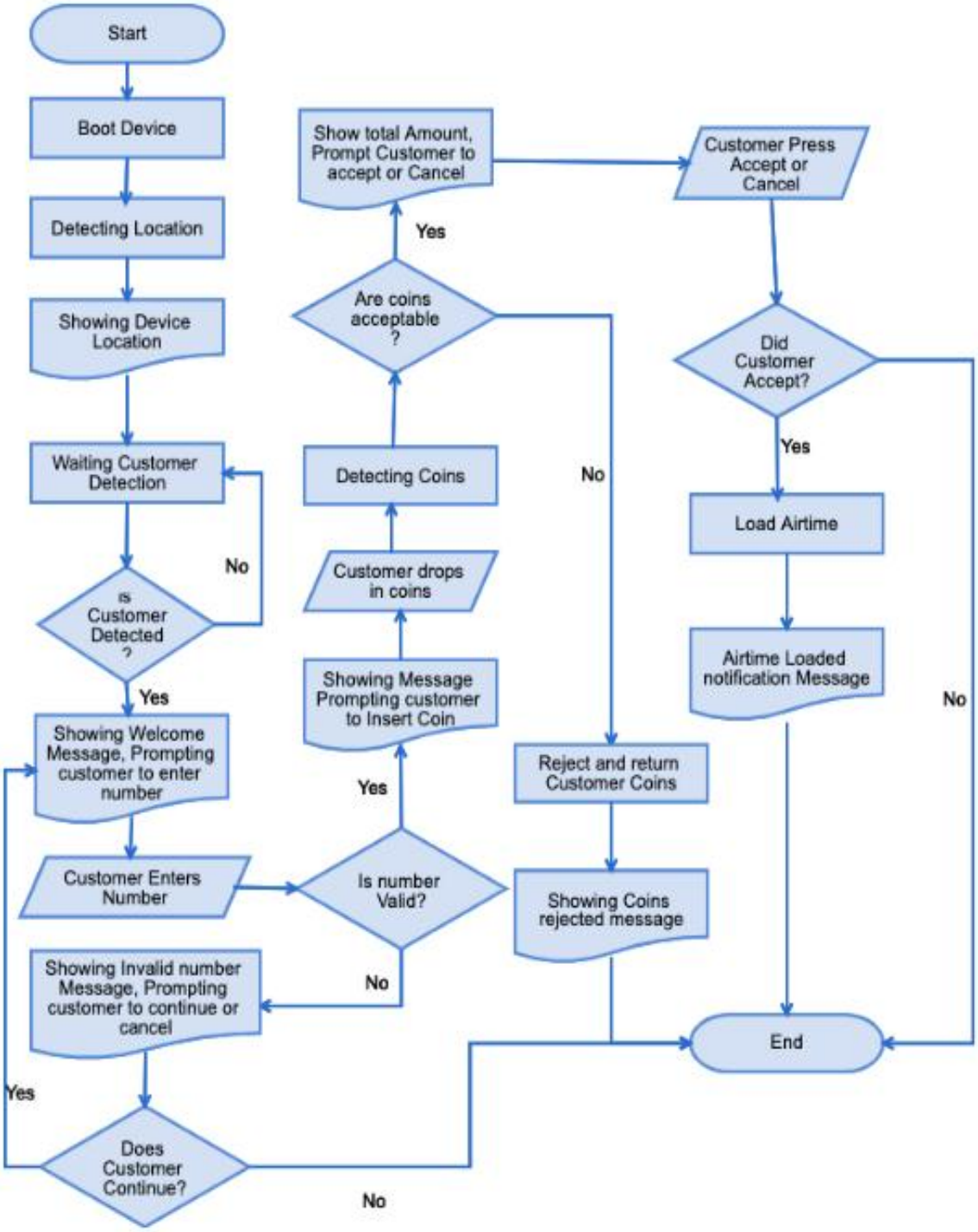

Figure 2: System Flowchart

Source: Researchers' data

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RESULT, ANALYSIS AND DISCUSSION

Prototype Circuit Diagram

A circuit diagram also called a standard diagram is a simplified traditional graphical illustration of a circuit. Unlike a block diagram or format diagram, a circuit diagram shows the real twine connections being used. A circuit diagram is a simplified illustration of the additives of a circuit using either the images of the wonderful components or trendy symbols. It suggests the relative positions of all the factors and their connections to one another.

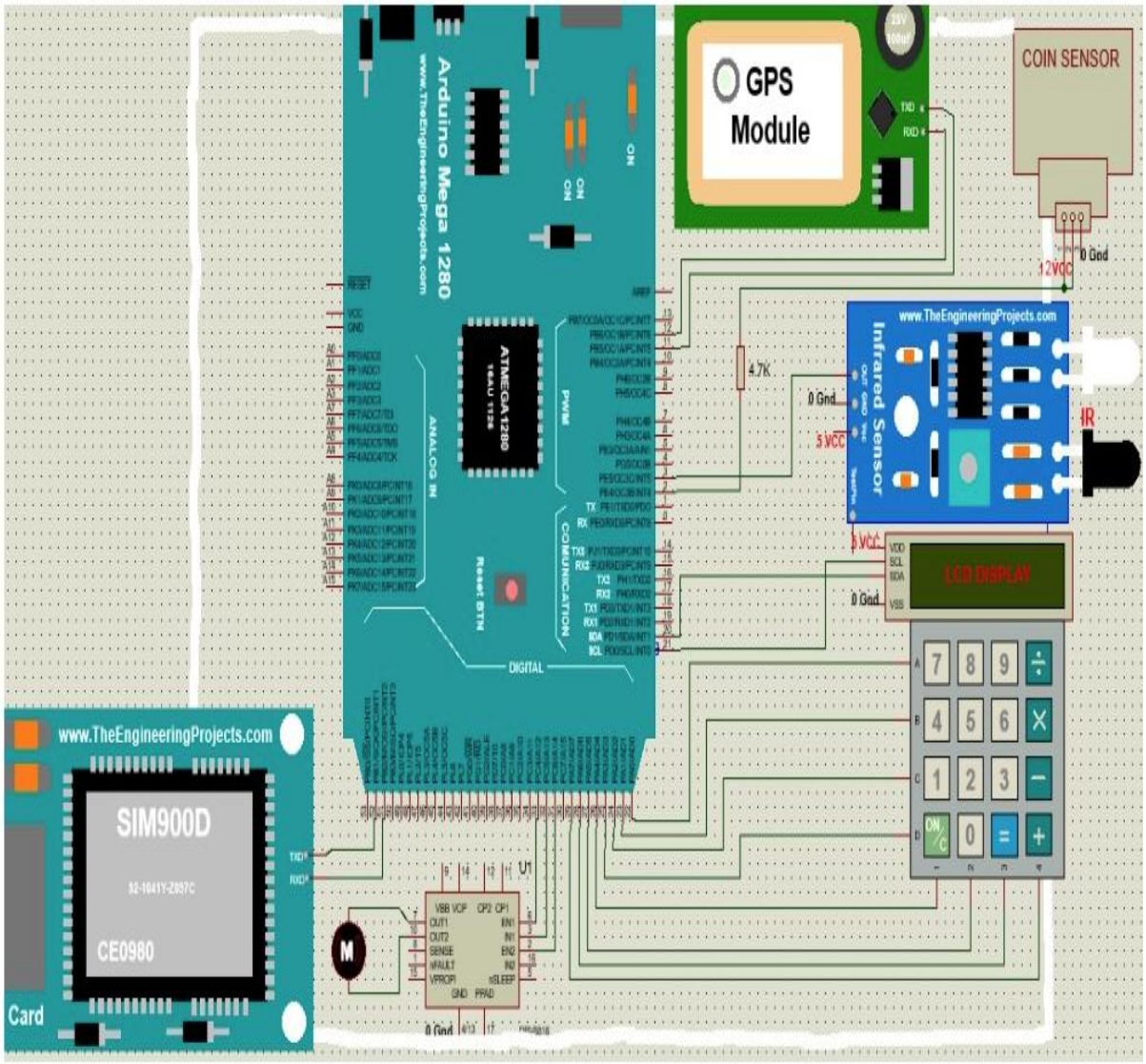

Figure 3: Prototype Circuit Diagram

Source: Researchers' data

Smart Airtime Vending Machine Three Layered Architecture

From the above perspective of IoT architecture, the Smart Airtime Vending Machine three layered architecture adopted three layered architectures as its IoT architecture with its three layers distributed as follows: The SAVM system high level architecture consists of sensors at perception layer, wireless communication at network layer and cloud services at application layer.

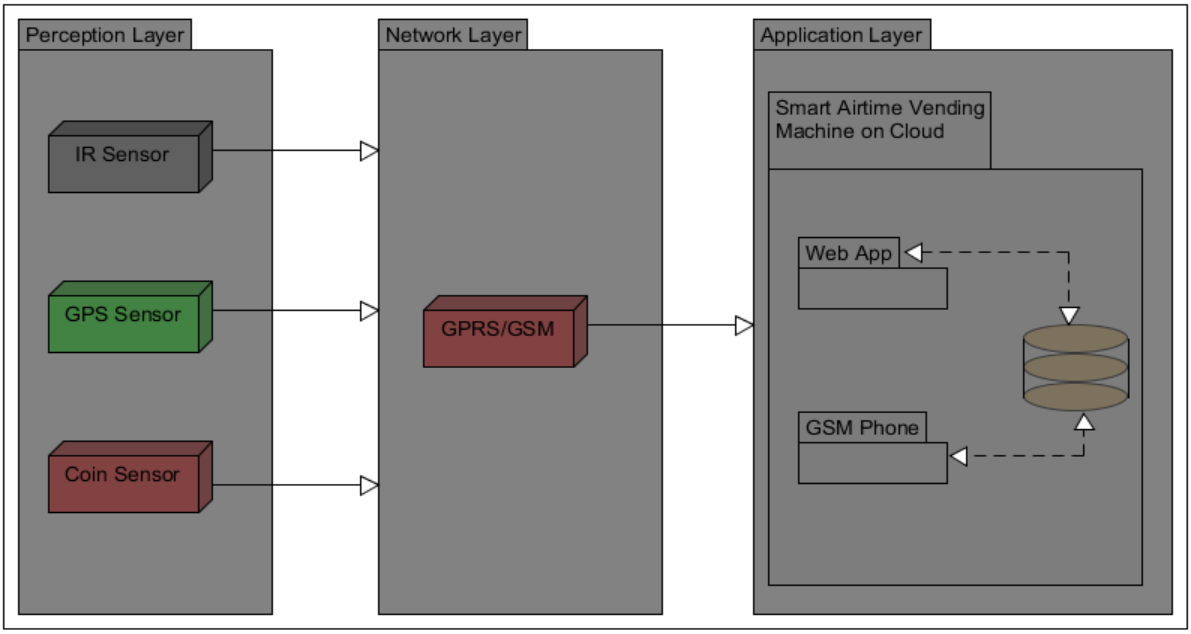

Figure 4: Three layered architecture

Source: Researchers' data

Smart Airtime Vending Machine System Components Model

The SAVM is a hybrid system, it combines different components with different technologies, and this gives the system to be heterogeneous design system. The system design is expected to be user-friendly and does not require specific knowledge or trainings. The main SAVM feature enables automatic way of thing connection, and at the same time it provides and ensures directly or indirectly always responsive services. The three-layered architecture of the SAVM is composed of five main components and seven sub components connected all together in three layers: VM component, Agent component, Customer component, Admin component, Cloud component.

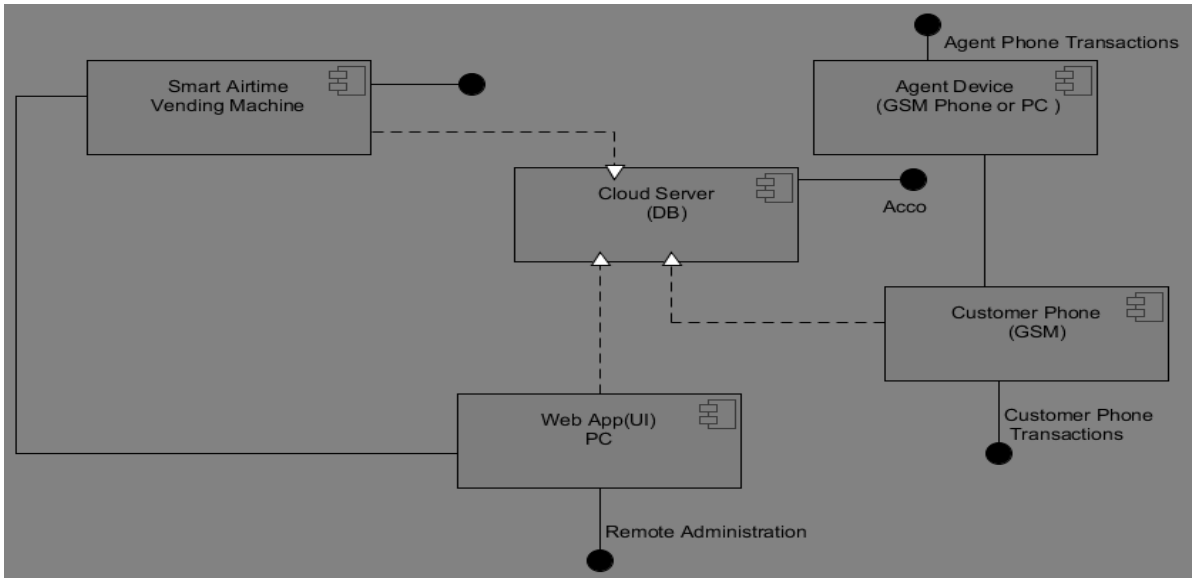

Figure 5: System components diagram

Source: Researchers' data

Smart Airtime Vending Machine System Components Model Description

1. **VM Component**: Smart airtime vending machine as the main component of the system consist of different modules with different technologies which are interconnected together to perform the main goal of this research. The Arduino ATmega used as control unit. The multi-coin selector which support six different coins is used to accept or reject coins based on the ones are programmed too, the Motion detection – IR Proximity Sensor which is used to detect the vending machine's customers, GSM/GPRS module used as communication module to link the vending machine with the cloud remote server, the GPS Module used to locate the vending machine, The DC Servo motor used to return the coins in case the transaction is cancelled, LCD used as vending machine display, the keypad used as input device and a real -time clock (RTC) as a clock that continues song of the modern-day time and that may be used with a view to program actions at a certain time.
2. **Agent Component:** Smart Phone or Person Computer: Smart phone with GSM embedded technology that serves to manage and monitor airtime transactions via web application. With this component the agent is able to view all transactions and their status (successful and failed), view agent airtime balance, vending machine status (ON or OFF) and its location. To ensure the security the system the agent can use multi factor authentication means username and password or SMS based OTP authentication.
3. **Customer Component**: GSM Phone: This component consists of a mobile phone that help the customer to receive the airtime dispensed by the vending machine. It receives also the SMS notification that shows airtime transaction information.
4. **Admin Component:** Web App and person computer or smart phone: This component consists on a web application interface which help the administration to manage and monitor the system remotely. It allows the admin:
    - To manage the vending machine (add VM, modify VM info, remove VM, view VM status and location
    - To manage the agent (add agent, modify agent info, view agent balance and remove agent
    - To view transactions (view all transactions and their status, Filter transactions)
    - To generate a reports
5. **Cloud Component:** Web server and Database server: Data engine of the system from cloud services such as data storage, security, privacy and execution of instruction

Smart airtime vending machine schematic diagram

A schematic diagram is a photo that represents the additives of a system, device, or different item the usage of abstract, regularly standardized symbols and lines. Schematic diagrams play a pivotal role in a variety of layout approaches, supplying a visual representation of all the components, individual tasks, and connections which are required to facilitate the operation of a device, circuit, mission, manner, or workflow.

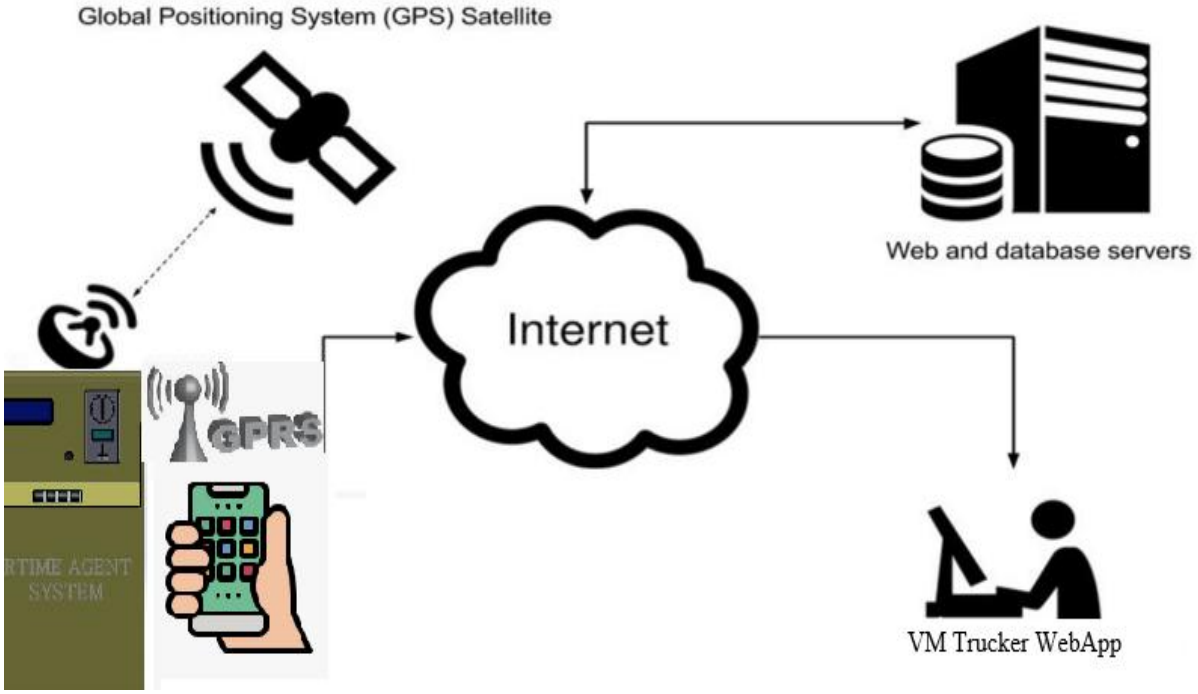

Figure 6: Schematic diagram

Source: Researchers' data

SYSTEM RESULTS

The prototype of the proposed gadget was built the usage of bodily devices. The gadgets used are Arduino Mega, Coin sensor, infers sensor, GPRS/GSM module, GPS, LCD, and keypad

System Prototype.

To build a prototype of the proposed system, the interconnection of all components was done systematically and end by a successful smart airtime vending machine. The programs' codes were uploaded into the real Arduino mega board hardware using Arduino IDE software. Furthermore, a web-based application called Air Time Vending Machine was developed as the user interface for information visualization, the database for airtime transaction data storage, and vending machine remote monitoring. This figure shows the interconnection of vending machine components, its show also Some of display message which comes to the screen to guide the customer to put money(coins) in and airtime being loaded to his/her telephone.

Figure 7: Fixing of vending machine components

Source: Researchers' data

This figure 7 indicate the fixing of vending machine component in housing

Figure 8: A picture of vending machine after fixing all components

Source: Researchers' data

This figure 8 indicate the vending machine after fixing all component in the housing

System Visualization

The developed web-based application called Air Time Vending Machine is used to visualize the Air Time Vending Machine information which helps the administrator and the airtime agent to get real-time information about the operations of the machine. The visualized information is represented in a number of the dashboard and by the graph, which shows the transaction amount versus the transaction time.

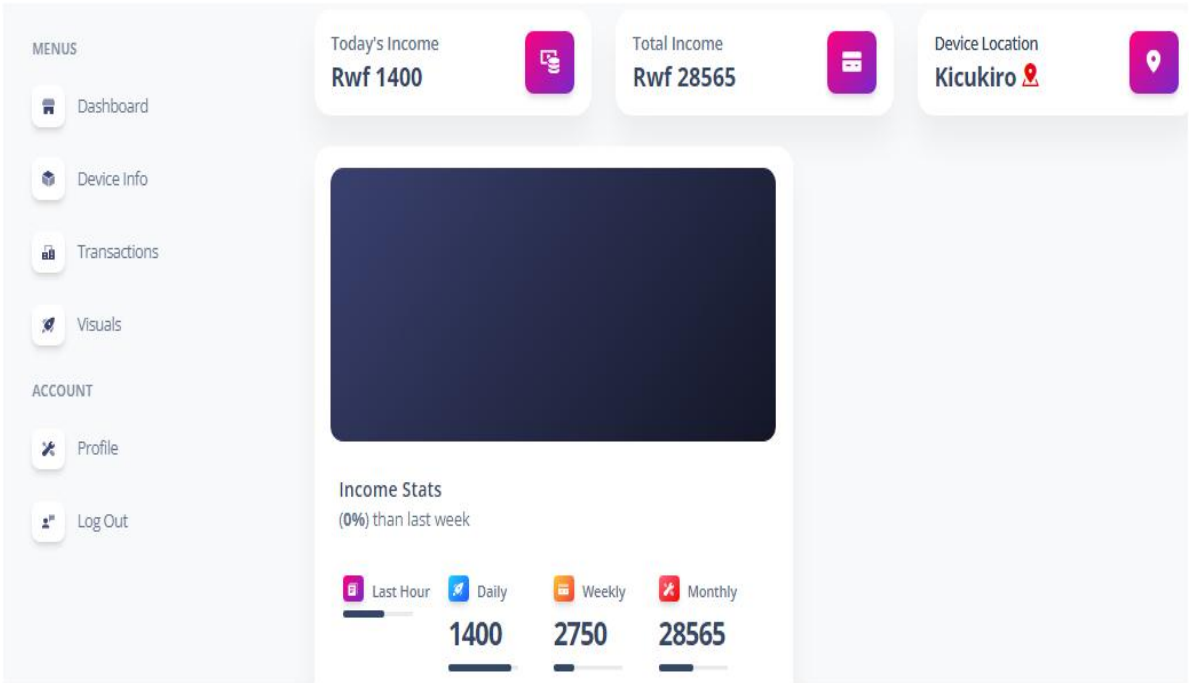

Figure 9: Screenshot of monitoring app dashboard of the prototype

Source: Researchers' data

This figure 9 shows admin dashboard where indicates the today's income, total income, device location, device information, transactions and some visual representations.

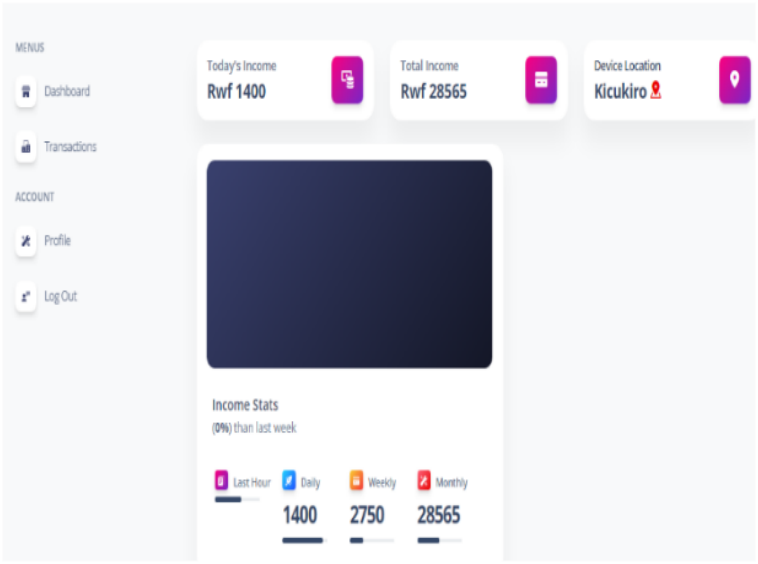

Figure 10: Screenshot of agent monitoring app dashboard

Source: Researchers' data

Figure 10 shows admin dashboard where indicates the today's income, total income, device location and device information

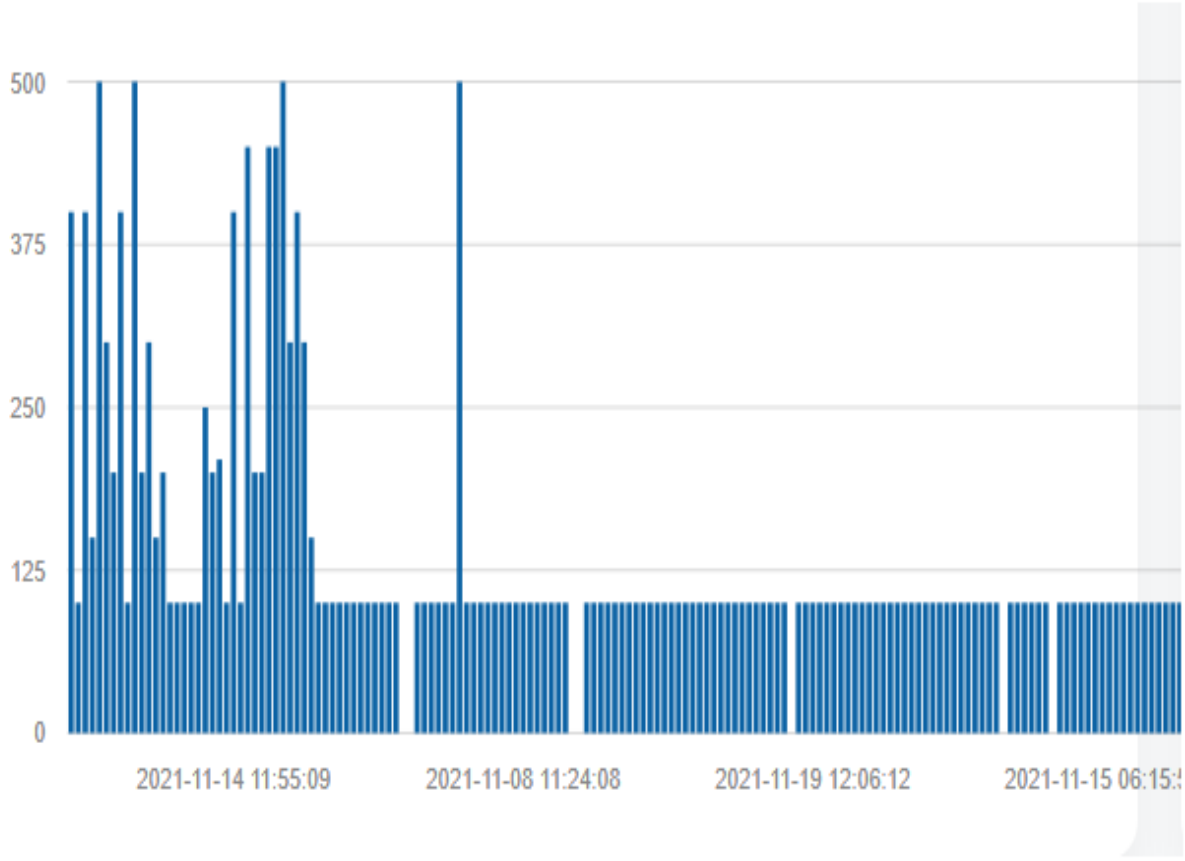

Figure 11: Transferred amount versus transaction time

Source: Researchers' data

Figure 11 shows the transaction amount versus the transaction time

SYSTEM ANALYTICS

Analytics and results aim is to explain the findings and the graphs of the results. The analytics was done using python where three algorithms such as Linear Regression, Decision tree, and random forest were used. After the results from that analysis was the key to concluding if the goals were achieved.

Scatter Plot - Amount vs Population

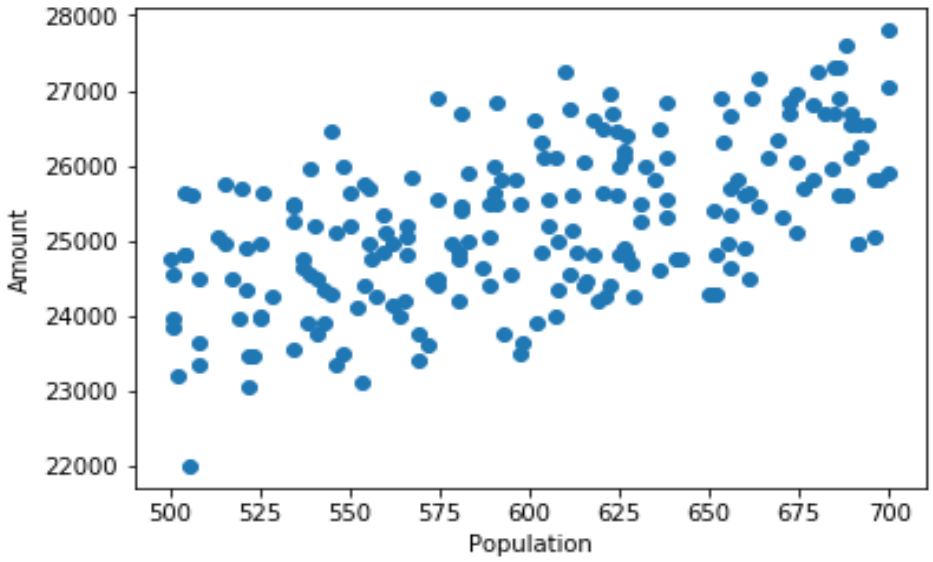

Figure 13: Amount of money vs Population

Source: Researchers' data

The scatter plot indicates the amount versus the population, the results show that the amount generated has a link with the population. As the population increases the amount also increases

Scatter Plot - Amount vs size cell phone handset

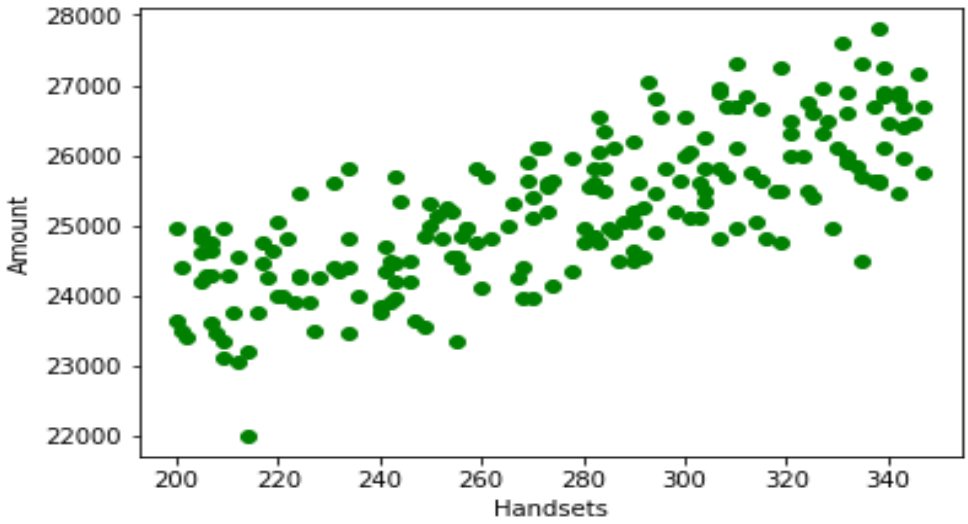

Figure 14: Amount of money vs size cell phone handset

Source: Researchers' data

The scatter plot indicates the amount of money versus the cell phone handsets, the results indicate that the amount generated has a link with the cell phone handsets. As the cell phone handsets increase the amount also increases

Transctions_Average based on sessions

	Session_Day	Session_Week	Handsets	Population	Size	NEW_AMOUNT
0	Afternoon	Working-Day	314	513	7819	25050
1	Break-Time	Working-Day	308	682	11940	26700
2	Afternoon	Week-End	212	611	7177	24550
3	Morning	Working-Day	273	638	6353	25550
4	Afternoon	Working-Day	308	555	10129	25700

Figure 15: Average based on sessions

Source: Researchers' data

Figure 15 indicate the amount of the machine have dispensed based on the session of the day and the week

Original dataset with pre-processed dataset

	Afternoon	Break-Time	Evening	Morning	Week-End	Working-Day	Session_Day	Session_Week	Handsets	Population	Size	NEW_AMOUNT
0	1	0	0	0	0	1	Afternoon	Working-Day	314	513	7819	25050
1	0	1	0	0	0	1	Break-Time	Working-Day	308	682	11940	26700
2	1	0	0	0	1	0	Afternoon	Week-End	212	611	7177	24550
3	0	0	0	1	0	1	Morning	Working-Day	273	638	6353	25550
4	1	0	0	0	0	1	Afternoon	Working-Day	308	555	10129	25700

Figure 16: Original dataset with pre-processed dataset

Source: Researchers' data

Final dataset to be modelled

	Afternoon	Break-Time	Evening	Morning	Week-End	Working-Day	Handsets	Population	Size	NEW_AMOUNT
0	1	0	0	0	0	1	314	513	7819	25050
1	0	1	0	0	0	1	308	682	11940	26700
2	1	0	0	0	1	0	212	611	7177	24550
3	0	0	0	1	0	1	273	638	6353	25550
4	1	0	0	0	0	1	308	555	10129	25700

Figure 17: Final dataset to be modelled

Source: Researchers' data

This model shows the dataset to be modelled, with the corresponding cell phone handset and population parameters that impact the transections

Model 1 Results: Linear Regression

```
Columns:  Index(['Afternoon', 'Break-Time', 'Evening', 'Morning', 'Week-End',
       'Working-Day', 'Handsets', 'Population', 'Size', 'NEW_AMOUNT'],
      dtype='object')
Model Coefficient:  [-3.70517211e+01  6.11064178e+01  8.16795192e+01 -1.05734216e+02
  4.44028548e+01 -4.44028548e+01  1.82097738e+01  1.04537306e+01
  4.51021023e-03]
Model interceipt:  13904.292947262536
======Model 1 of LINEAR REGRESSION Results=====
Score of Training is:  0.8903852117143808
Score of Testing is:  0.9120021731611317
Errors in the Training is:  119682.84436695972
Errors in the Testing is:  97575.82159684028
```

Figure 18: Linear Regression Results

Source: Researchers' data

Model 2 Results: Decision Tree

```
======Model 2 of Decision Tree Results=====
Score of Training is:  0.8155324323288857
Score of Testing is:  0.7808301474106807
Errors in the Training is:  201410.80904892852
Errors in the Testing is:  243025.07463985746
```

Figure 19: Decision Tree Results

Source: Researchers' data

Model 3 Results: Random Forest Regression

```
======Model 3 of Random Forest Regressor=====
Score of Training is:  0.8561406510631853
Score of Testing is:  0.8274729914291904
Errors in the Training is:  157072.7484750867
Errors in the Testing is:  191305.45848327866
```

Figure 20: Decision Tree Results

Table 1: Results comparison tables of model results

Metrics	Dataset	Linear Regression	Decision Tree	Random Forest Regression
SCORE	Training	89%	81%	85%
	Testing	91%	78%	82%
MSE	Training	119682	201410	157072
	Testing	97575	243025	191305

The table 1 is summarising the results of three models used (as indicated in figure 18,19 and 20) to find the one with high efficiency, as it is seen in the table Linear Regression is the best among Decision Tree and Random Forest Regression.

CONCLUSION

This Research project explores the use of the Internet of things in vending machine. The projects works include requirement analysis, literature review, system design, and experimental work of the IoT-based prototype to dispense airtime using coin sensor and GPRS/GSM technology for communication and GPS technology for monitoring and tracking and cloud Server, and database for data processing and storage. The prototype improved the airtime vending system's efficiency and sustainable management of airtime agent. It facilitates safe selling and buying of airtime across the country especially in rural area where to get airtime seems to be a problem. The Internet is also used for linking cloud platform and application users.

RECOMMENDATION

This research aim was to develop an IoT based Smart Airtime Vending Machine that helps rural citizens to buy airtime using coins where they have to enter the mobile number using a keypad then insert coin in the vending machine, and automatically the machine dispenses the airtime equivalent to the amount inserted and also to analyse machine transaction data using Python programming and regression as a machine learning technique.

However, the developed machine changed into for finishing touch of the writer's Master's degree studies. Thus, there are a few barriers from this studies assignment that wishes to be addressed in future research.

This prototype must be verified inside the special rural area of the county to be stepped forward. The system should also be added more functionalities like using currency note as to buy airtime, mobile money option where citizen can deposit and withdraw money without facing the current mobile money agents.to get best accuracy it will be good for research to using multiple vending machines on different location and take long time for building a good sample dataset.

REFERENCES

Alharbe, N., Atkins, A. S., & Akbari, A. S. (2013, December). Application of ZigBee and RFID Technologies in Healthcare in Conjunction with the Internet of Things. In *Proceedings of International Conference on Advances in Mobile Computing & Multimedia* (pp. 191-195).

Ali, B. (2016). Internet of Things Based Smart Homes: Security Risk Assessment and Recommendations.

Alrehily, A., Fallatah, R., & Thayananthan, V. (2015). Design of Vending Machine using Finite State Machine and Visual Automata Simulator. *International Journal of Computer Applications*, *115*(18)

Amin, R., & Rahman, M. (2018). Artificial Intelligence and IoT in Dairy Farm. *Malaysian Journal of Medical and Biological Research*, *5*(2), 131-140.

Benezeth, Y., Emile, B., Laurent, H., & Rosenberger, C. (2008, July). A real time human detection system based on far infrared vision. In *International Conference on Image and Signal Processing* (pp. 76-84). Springer, Berlin, Heidelberg.

Bihlmayr, W. (2007). OLEO Display Driver for the HCS08 Family. *Freescale Semiconductor Application Note*, 1-42.

Chen, X. Y., & Jin, Z. G. (2012). Research on key technology and applications for internet of things. *Physics Procedia*, *33*, 561-566.

Desai, P., Jadhav, M., Maruti, S., Patil, M., Shivaji, P., Giri, M., & Sambhaji, N. (2017). Automatic chocolate vending machine by using Arduino Uno. *International Journal of Innovative Research in Computer Science &Technology (IJIRCST), ISSN*, 2347-5552.

Dua, A., Rustagi, C., & Bhardawaj, A. (2014). A novel approach to designing intelligent vending machines. *International Journal in IT & Engineering*, *2*(12), 38-50.

Eckert, M. (2014). *Fpga-based system virtual machines* (Doctoral dissertation, Universitätsbibliothek der HSU/UniBwH).

Ekşioğlu, M., Kiriş, E., Çakir, T., Güvendik, M., Koyutürk, E. D., & Yilmaz, M. (2013). Design, User Experience, and Usability. Web, Mobile, and Product Design. *Lect. Notes Comput. Sci.(including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, *8015*, 173-82.

Goddard, W., & Melville, S. (2004). *Research methodology: An introduction*. Juta and Company Ltd

Gruber, S., BUBER, R., RUSO, B., & GADNER, J. (2005). The commodity vending machine. *InForum Ware International*, *2*, 32-42.

Hall, A. (2015). Vending Machines.

Husain, B. M., & Monnet, W. M. A. (2017, February). An internet of things Application through GPRS. In *3rd International Engineering Conference on Developments in Civil & Computer Engineering Applications* (p. 153).

Jadhv, R., Jejurkar, M., Kave, P., & Chaudhari, H. P. (2017). Smart coffee vending machine using RFID. *Instrumentation Engineering department, Advances in Wireless and Mobile Communications*, *10*, 793-800.

Karthika, M. V., Jagadeesh, S., Karthick, R. A., & Teja, K. S. (2019). Smart Computerized Vending Machine Enhanced With IOT Technology

Kim, K., Park, D. H., Bang, H., Hong, G., & Jin, S. I. (2014, January). Smart coffee vending machine using sensor and actuator networks. In *2014 IEEE International Conference on Consumer Electronics (ICCE)* (pp. 71-72). IEEE.

Kisan, B., & Bhise, S. K. (2017). Zigbee and RFID Based Student Attendance Monitoring System with Energy Saving.

Kocurek, C. A. (2014). Rendering Novelty Mundane: Technical Manuals in the Golden Age of Coin-Op Computer Games. *Computer Games and Technical Communication: Critical Methods and Applications at the Intersection*, 55-67.

Lin, Y. B., Rao, H. C. H., & Chlamtac, I. (2001). General Packet Radio Service (GPRS): architecture, interfaces, and deployment. *Wireless Communications and Mobile Computing*, *1*(1), 77-92.

Manmohan, M. H., Ankitha, N. B., Aishwarya, G., & Trupti, K. (2019). A review based on milk and it's vending. *Int J Res Eng Sci Manag Res*, *2*, 346-348.

Maulud, D., & Abdulazeez, A. M. (2020). A review on linear regression comprehensive in machine learning. *Journal of Applied Science and Technology Trends*, *1*(4), 140-147.

Mbongue, J., Hategekimana, F., Kwadjo, D. T., Andrews, D., & Bobda, C. (2018, July). Fpgavirt: A novel virtualization framework for fpgas in the cloud. In *2018 IEEE 11th International Conference on Cloud Computing (CLOUD)* (pp. 862-865). IEEE.

Megel, M. E., & Heermann, J. A. (1994). Methods of data collection. *Plastic surgical nursing: official journal of the American Society of Plastic and Reconstructive Surgical Nurses*, *14*(2), 109-110.

Murena, E., Sibanda, V., Sibanda, S., & Mpofu, K. (2020). Design of a control system for a vending machine. *Procedia CIRP*, *91*, 758-763.

Patel, K. K., Patel, S. M., & Scholar, P. (2016). Internet of things-IOT: definition, characteristics, architecture, enabling technologies, application & future challenges. *International journal of engineering science and computing*, *6*(5).

Plaha, B., & Singh, B. (2012). Design and Development of Vending Machine using AVR ATmega 8515 Microcontroller. *International Journal of Advanced Research in Computer Science*, *3*(3).

Pongswatd, S., Smerpitak, K., & Thepmanee, T. (2020). Smart coffee vending machine based on IoT concept. *International Journal of Innovative Computing, Information and Control*, *16*(4), 1441-1448.

Ramzan, A., Rehman, S., & Perwaiz, A. (2017, April). RFID technology: Beyond cash-based methods in vending machine. In *2017 2nd International Conference on Control and Robotics Engineering (ICCRE)* (pp. 189-193). IEEE.

Ratnasri, N., & Sharmilan, T. (2021). Vending Machine Technologies: A Review Article. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, *58*(2), 160-166.

Sibanda, V., Munetsi, L., Mpofu, K., Murena, E., & Trimble, J. (2020). Design of a high-tech vending machine. *Procedia CIRP*, *91*, 678-683.

Vijayaragavan, M., Rajendirakumar, R., & Nakkeeran, R. (2020). Automatic milk ATM machine for rural area people. *Int J Innov Technol Explor Eng*, *9*(2), 1201-1203.

Yang, Z. L., Zhao, L. Y., & Gu, L. T. (2015). The Internet of things coffee vending machine. In *Applied Mechanics and Materials* (Vol. 734, pp. 340-344). Trans Tech Publications Ltd.