



**UNIVERSITY OF
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NSBM Green University

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Internet of Things (IoT) Group Project

Project Initiation Document

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Background

Smart vending machines are transforming the way businesses sell products and interact with customers. By utilizing technology, these machines offer a range of benefits, including increased efficiency, reduced costs, and enhanced customer engagement. Recognizing the potential of smart vending machines, we chose this project to develop an innovative IOT-based smart vending machine system. Our primary goal is to create a system that not only automates the vending process but also provides valuable insights into consumer preferences and product performance. This system will enable businesses to make informed decisions, optimize their operations, and ultimately, achieve greater profit and customer satisfaction.

Literature Review

Smart vending machines have emerged as a promising solution for improving the efficiency and effectiveness of ordinary vending machines in recent years. To provide a smoother and data-driven vending experience, these machines combine a variety of technical innovations, including IOT connectivity, cashless payment systems, and real-time inventory management. In this literature review, we aim to explore previous research and developments in the field of IOT-based smart vending machines. We will investigate the methods, approaches, and results of previous studies, critically evaluate their solutions, and identify gaps and shortcomings that our project seeks to address.

Previous Research

Several research studies have explored the development and implementation of smart vending machines, each contributing to the advancement of this technology. One notable study is proposed an IoT-based smart vending machine system that utilizes RFID tags for product identification and a cloud-based platform for remote monitoring and management. The system demonstrated improved inventory management, reduced operational costs, and enhanced customer satisfaction (MDPI, 2021).

Another study is focused on incorporating machine learning algorithms into smart vending machines to optimize product placement and pricing based on real-time sales data and customer preferences. Their findings revealed that the machine learning approach significantly increased sales and reduced product waste (Anon., 2023).

Gaps and Our Project's Contribution

Previous research has made major contributions to the creation of smart vending machines, gaps and inadequacies remain, which our study seeks to address. The integration of customer engagement strategies is one noticeable area for improvement. Current smart vending machines are largely concerned with transactional aspects, ignoring the opportunity to connect with customers and gain useful insights.

By implementing interactive elements into our smart vending machine technology, we want to bridge this gap. Personalized product suggestions, interactive games, and surveys are examples of features that can improve customer engagement, build brand loyalty, and give vital data for refining product offers and marketing campaigns.

In addition, we plan to investigate the use of analytics approaches to improve vending machine operations. Our technology can predict demand trends and make proactive adjustments to inventory levels, pricing, and product placement by analyzing past sales data and consumer preferences.

Aim

This project is aimed at developing an IoT-based smart vending machine system that incorporates interactive features and advanced analytics to enhance customer engagement, optimize operations, and provide valuable insights for informed decision-making.

Project Goals

- Create a smart vending machine system based on IoT that seamlessly connects hardware and software components for better functionality.
- Use interactive elements like personalized product suggestions, interactive games, and surveys to engage customers, increase brand loyalty, and collect crucial information.
- Integrate advanced analytics approaches, such as predictive modeling, to examine past sales data, consumer preferences, and outside variables in order to forecast demand patterns and make proactive changes to inventory levels, price, and product positioning.
- Implement remote monitoring and management capabilities to enable real-time inventory tracking, sales data analysis, and machine performance optimization.
- Design a user-friendly interface that provides a seamless and intuitive vending experience for customers.
- Ensure the security and reliability of the system to protect customer data and prevent unauthorized access or tampering. (Secure payment Gateways and contact numbers etc.)
- Before deployment, conduct thorough testing and assessment to evaluate the system's functionality, performance, and security.

System Overview

We are planning to develop an automated vending machine with a cooling system is an innovative IOT project to give people an efficient and reliable experience. This report provides an overview of the sensor requirements, preferred computer system, data storage method, interface for infrastructure visualization, management, administration, and configuration.

Sensor requirements

We are planning to use several sensors depending on the outcomes we are planning to achieve in our project. Which include, choosing the required items, sensors for the helical coil to carry out the operation when the user selects the product, checking the coolness of the products etc. Following are the sensors assigned for the above tasks.

1. DC-DC LM2596 Buck Converter
 - The LM2596 Buck Converter is essential for regulating the voltage supplied to various components within the vending machine, ensuring stable and reliable power distribution.
2. User Interface Components:
 - Display (LCD or LED): A display can provide real-time information, such as product availability and temperature readings.
3. Microcontroller (e.g., Arduino, Raspberry Pi):
 - A microcontroller can be the brain of your system, collecting data from various sensors, controlling motors, and managing the overall vending machine operation.
4. Temperature Sensors
 - Digital Temperature Sensors (I2C or One-Wire): These sensors are easy to interface with microcontrollers and can provide accurate temperature readings. They are suitable for monitoring the temperature of individual items.
5. Motor Position or Rotation Sensors:
 - Encoder Sensors: These can be used to track the rotation and position of motors, helping to monitor the dispensing process and ensure accurate product delivery.

Embedded computer system

- The chosen system architecture employs an embedded computer system, with the Arduino board serving as the central processing unit. This embedded solution provides real-time control, efficient data processing, and seamless coordination of various sensors and actuators within the smart vending machine.

Data processing tasks

- Data collection.
 - The first step is to collect the data from the sensors. This could be done using a microcontroller or a single-board computer. The microcontroller or single-board computer would be responsible for reading the data from the sensors and sending it to the cloud for processing.
- Data preprocessing.
 - Once the data has been collected, it needs to be preprocessed. This may involve cleaning the data and converting the data to a consistent format.
- Once the data has been preprocessed, it can be analyzed to gain insights into the vending machine's operation and customer behavior. For example, the data could be used to:
 - Track inventory levels and identify when products need to be restocked.
 - Identify popular and unpopular products.
 - Identify peak and off-peak sales times.
 - Detect product jams and other problems.
 - Analyze customer demographics and preferences.
- Decision making

The insights gained from data analysis and machine learning can be used to make decisions about how to operate the vending machine more efficiently and effectively. For example, the data could be used to:

 - Adjust product prices to maximize profits.
 - Optimize inventory levels to avoid stockouts.
 - Schedule preventive maintenance to avoid machine failures.
 - Target specific customer segments with personalized promotions.

Expected data storage method on servers/cloud, detail the data analysis you intend to perform using the collected data.

- Sensors/IoT devices: The sensors/IoT devices collect information on the operation of the vending machine and customer behavior. This information could include temperature, inventory levels, product sales, and consumer characteristics.
- Wi-Fi module: The Wi-Fi module allows the vending machine to connect to the internet.
- Cloud or server: The cloud or server stores the data collected from the sensors/IoT devices and provides access to the data for data analysis, and decision making.

- The vending machine's Wi-Fi module connects to the internet via a Wi-Fi access point. The Wi-Fi access point can be a router located near the vending machine or a public Wi-Fi hotspot. After connecting to the internet, the Wi-Fi module can communicate with the cloud or server via a variety of protocols. The data collected from the vending machine is stored in the cloud or server and is accessible for data analysis, machine learning, and decision making.

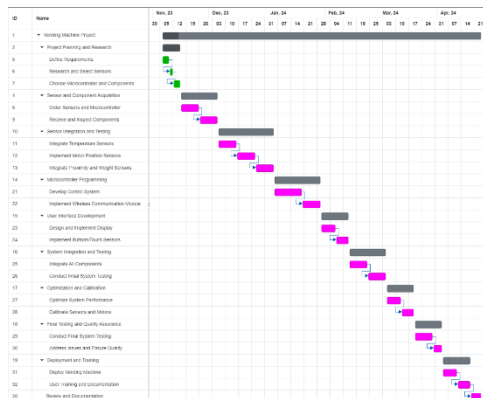
Explain your approach for developing an interface for infrastructure visualization, management, administration, and configuration.

- Define Requirements: Identify key features.
- Dashboard Design: Create an intuitive overview.
- Real-time Monitoring: Use sensors for live data.
- Inventory Management: Track and manage stock.
- Sales Analytics: Analyze sales trends and data.
- Remote Configuration: Enable remote adjustments.
- Alerts and Notifications: Set up a system for critical alerts.
- Logging and Audit Trail: Track user activities.
- Testing: Thoroughly test for bugs and usability.
- Documentation: Provide comprehensive user guidelines.
- User Feedback and Iteration: Gather feedback for continuous improvement.

Conclusion

Our project is an automated vending machine which aims to contribute to the evolution of smart vending machines. We are considering the key fields such as cost effectiveness, connectivity, and user experience to overcome the challenges faced by other projects regarding IOT vending machines. We are planning to give users a better experience with a user-friendly Interface, real time monitoring, user friendly access starting from payment methods till getting the product to their hand. We are planning to use necessary sensors for the desired outcomes of our project. In summary our IOT based smart vending machine will influence the vending industry not only by automation but also engaging a better customer experience.

Gantt Chart



<https://drive.google.com/file/d/1wWoEJNJOIDFIRdDJSpfipawd5Yts7I-N/view?usp=sharing>

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Group Contribution

	Plymouth ID	Name (As appeared on DLE)	Contributed section
1	10898707	W M L R Wijekoon	Aim, System Overview
2	10898417	A M P A Aththanayake	Gantt Chart, Conclusion
3	10899645	J S Paravavithana	Background, Project Goals
4	10898545	H G C Lasanga	Literature Review