



IoT-Based Vending Machine Management System: Enhanced Functions and Intelligent Operations

S.Sureshkumar,

Assistant Professor, Department of Electronics and Communication Engineering, J.J. College of Engineering and Technology, Trichy, Tamilnadu

Dr.N.L.Venkataraman,

Assistant Professor, Department of Electronics and Communication Engineering, J.J. College of Engineering and Technology, Trichy, Tamilnadu

R.V.Kavya,

Assistant Professor, Department of Electronics and Communication Engineering, J.J. College of Engineering and Technology, Trichy, Tamilnadu

Abstract

This research presents a vending machine management system based on IOT (IoT) technology. The system incorporates advanced features in addition to traditional vending capabilities, including a comprehensive vending machine system, a communication system, and a backend information processing system. By leveraging IoT technology, the system enables efficient monitoring and management of vending machines, while also extracting valuable commercial insights from sales data. The system offers auto-reminders, locates nearby vending machines with similar goods, provides user-friendly selection options, and supports remote advertising management. This research aims to enhance the functionality and intelligence of vending machines through IoT integration.

Keywords: IOT, vending machine management, sales data analysis, geographical location, remote advertising

DOI Number: 10.48047/nq.2020.18.8.nq20227

NeuroQuantology 2020;18(8):203-208

203

Introduction

The vending machine industry has undergone significant advancements in recent years, driven by technological innovations and the growing demand for automated services. With the emergence of the IOT (IoT), traditional vending machines have evolved into intelligent systems capable of providing enhanced functionalities and improved user experiences.¹ This research focuses on the development and implementation of a vending machine management system based on IoT technology, aiming to revolutionize the way vending machines operate and serve customers.

Vending machines have long been popular for their convenience and accessibility. They provide a wide range of products, from snacks and beverages to personal care items, available 24/7 without the need for human intervention. However, traditional vending machines often face challenges in terms of inventory management, maintenance, and optimizing product offerings.² The advent of IoT technology presents an opportunity to address these challenges and transform vending machines into intelligent, data-driven systems.

The IoT-based vending machine management system proposed in this research comprises several key components. Firstly, a vending



machine system with enhanced functions beyond traditional vending capabilities is designed and implemented. This system incorporates state-of-the-art technologies such as touch screens, electronic payment systems, and inventory sensors to create a seamless and interactive user experience.⁴ Customers can browse through product catalogs, make purchases using various payment methods, and receive real-time updates on product availability. In addition to the vending machine system, a communication system is established to facilitate data exchange and remote management. Vending machine proprietors and managers can anticipate more efficient methods to

interact with customers, boost sales, and reduce costs by utilizing remote management and predictive maintenance. Sophisticated data analysis will aid them in aligning machines and inventory with each location, as well as acquiring valuable insights into the effectiveness of promotions, pricing, location, weather, seasonality, and other variables. While this development is promising for those who purchase the most recent vending machine models, numerous operators possess extensive fleets of vending machines that still have many years of service. These operators require immediate solutions to modernize these machines and benefit from the advantages of IoT (Figure 1).

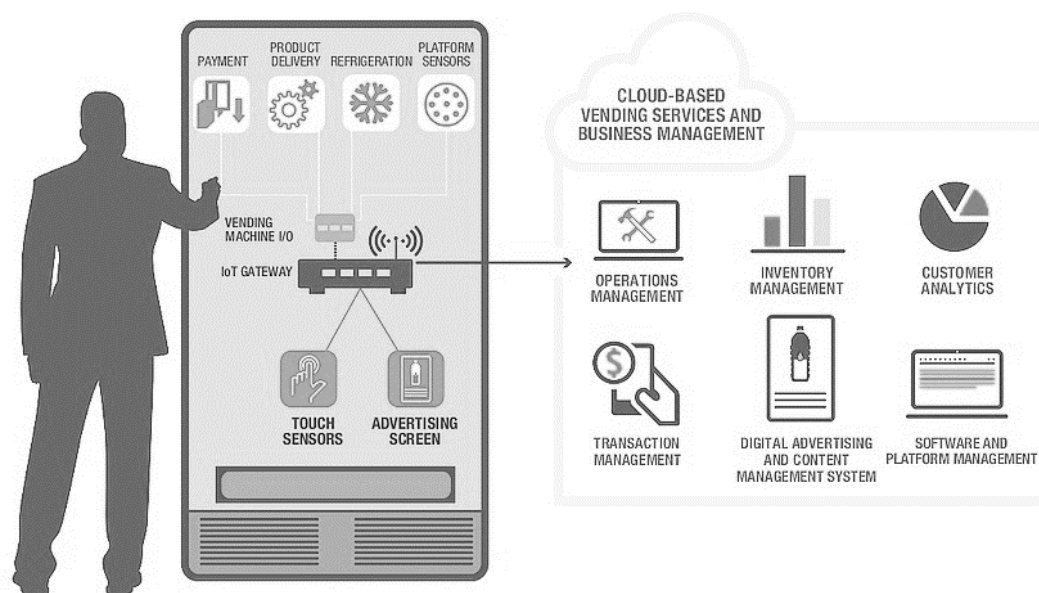


Figure 1. Operators of vending machines are seeking methods to link outdated machines to the Internet of Things (IoT) to capitalize on its numerous benefits

This allows operators to monitor the status of vending machines, track inventory levels, and receive notifications when maintenance or restocking is required.³ The communication system utilizes wireless connectivity and IoT protocols to ensure reliable and efficient communication between the vending machines and the backend information processing system. Speaking of the backend system, it plays a crucial role in the overall management of the vending machine network. It serves as a centralized hub for storing and analyzing data

collected from individual vending machines. The system tracks and stores information about the selling conditions of each vending machine, including sales volumes, popular products, and customer preferences.⁶ By leveraging data mining techniques, valuable commercial insights can be extracted, enabling operators to make informed decisions about inventory management, product placement, and marketing strategies. One of the notable features of the IoT-based vending machine management system is its ability to provide auto-reminders.

The system can analyze real-time sales data and predict when specific products are likely to run out. In such cases, the system can automatically send notifications to operators, prompting them to restock the vending machines in a timely manner.⁷ This feature ensures that customers always have access to their desired products, enhancing user satisfaction and optimizing revenue generation. Furthermore, the system leverages geographical location information to offer intelligent recommendations to users.

When a certain product is sold out in one vending machine, the system can identify the nearest vending machine with the same product in stock and display its location on the screen of the empty vending machine. This feature allows users to easily find alternative options nearby, saving time and ensuring a seamless shopping experience. Another significant aspect of the IoT-based vending machine management system is its remote advertising management capability. Operators can remotely control and manage the advertisements displayed on the vending machine screens.⁴ This feature enables targeted advertising campaigns based on customer demographics, purchasing patterns, and location. By delivering relevant and engaging advertisements, operators can maximize revenue potential and create new marketing opportunities.

This research aims to revolutionize the vending machine industry through the development and implementation of an IoT-based vending machine management system. By leveraging IoT technology, the system enhances the functionality, intelligence, and convenience of traditional vending machines. The proposed system allows for comprehensive monitoring, data-driven decision-making, and improved user experiences. Through advanced features such as auto-reminders, intelligent recommendations, and remote advertising management, the system offers operators new avenues for revenue generation and customer engagement.

Related Work

Traditional automatic vending machines in the market have limited functionality and operate in isolation, resulting in several weaknesses. Firstly, when a particular type of product is sold out, the vending machine fails to provide information to the customer regarding the location of nearby vending machines that still have the desired product in stock.⁸ This inconvenience hinders the customer's ability to find alternatives quickly and efficiently. Secondly, the existing vending machines lack the capability to promptly notify managerial personnel when certain products are sold out or when maintenance or restocking is required. This lack of real-time communication often leads to delays in addressing issues and maintaining the optimal functioning of the vending machines.

Moreover, the current vending machines do not record and analyze sales data based on different weather conditions or varying environmental factors. For instance, understanding which products sell better during high temperatures or under specific environmental conditions could provide valuable insights for inventory management and marketing strategies.⁹ Furthermore, the conventional vending machines do not offer personalized recommendations to customers based on their geographic location, climatic environment, health information, or other relevant factors. Tailored recommendations could enhance the customer experience by suggesting suitable products that align with their preferences and needs.

Additionally, the existing vending machines do not provide comprehensive sales data for different product categories under varying circumstances. This limitation hinders the ability of managerial personnel to gain insights into sales trends and make data-driven decisions for inventory management and business strategies.⁷ Moreover, most vending machines only support cash payments, lacking support for mobile payment options. This limitation creates inconvenience for customers who may not have the exact change or prefer cashless transactions.

Lastly, vending machines are typically placed in commercial areas, occupying significant space. Leveraging this space for advertising

purposes is not fully utilized in many vending machine services, missing out on the potential revenue and advertising opportunities that could be derived from integrating advertising media into the vending machines.¹⁰ Addressing these limitations and weaknesses, the proposed IoT-based vending machine management system aims to enhance the functionality and performance of traditional vending machines. By incorporating advanced features such as real-time inventory monitoring, automated notifications, data analytics, personalized recommendations, and mobile payment options, the system offers improved convenience, customer satisfaction, and revenue generation. Additionally, the integration of advertising capabilities maximizes the use of vending machine space and creates new marketing avenues. Through the utilization of IoT technology and comprehensive data management, the system revolutionizes the vending machine industry and sets a new standard for intelligent, connected vending machines.

Research Objective

The primary objective of this research is to develop and implement an IoT-based vending machine management system with enhanced functionalities. The specific research goals are as follows:

1. Designing and integrating a vending machine system that goes beyond traditional vending functions: The research aims to develop a vending machine system that offers more than just the basic function of selling goods. This involves enhancing the system with additional features and modules such as sensing capabilities, display interfaces, advertising management, and information storage. The goal is to create a vending machine system that provides a comprehensive and improved user experience.
2. Establishing a communication system to facilitate data exchange and remote management of vending machines: To enable effective management and monitoring of the vending machines,

a communication system is implemented. This system allows for seamless data exchange between the vending machines and a central management server. It enables remote access to vending machine data, facilitates real-time monitoring, and enables remote management and control of the machines.

3. Developing a backend information processing system capable of storing and summarizing sales data from individual vending machines: To effectively manage the vending machine system, a backend information processing system is designed and implemented. This system is responsible for collecting and storing sales data from each vending machine. It processes and analyzes the data to generate meaningful insights and summaries regarding the sales performance of different products and vending machines.
4. Utilizing data mining techniques to extract useful commercial information for managing staff and improving decision-making: The research focuses on leveraging data mining techniques to extract valuable commercial information from the collected sales data. By applying data mining algorithms and analysis methods, the research aims to identify patterns, trends, and correlations in the sales data. This information can be used to make informed decisions, improve inventory management, optimize product placement, and enhance overall vending machine performance.
5. Implementing advanced features such as auto-reminders, geographical location-based recommendations, and remote advertising management: The research aims to incorporate advanced features into the vending machine system based on IOT technology. These features include auto-reminders to notify the management personnel when certain

products are sold out, geographical location-based recommendations to suggest nearby vending machines with similar products, and remote advertising management to facilitate targeted advertising campaigns. These features enhance the functionality and convenience of the vending machine system while improving the user experience.

IoT-Based Vending Machine Management System: Enhanced Functions and Intelligent Operations

The IOT-based automatic vending machine management system not only includes the traditional function of selling goods but also incorporates additional features to enhance its capabilities. This system consists of a communication system and a background information processing system. In addition to the basic vending function, the system is equipped with various modules to enhance its functionality. These modules include a sensing module, a display module, an advertising management module, and an information storage module. The sensing module enables the vending machine to gather data and sense its surroundings. The display module provides a screen or interface for users to interact with the vending machine and view product information. The advertising management module allows for the management and display of advertisements on the vending machine. The information storage module stores relevant data for future reference. To improve convenience and efficiency, each type of product in the vending machine is assigned a unique two-dimensional code. This code contains information such as the product name, vending machine number, quantity available, and contact details for customer service. By integrating these features, the automatic vending machine management system based on the IOT aims to provide a more advanced and user-friendly vending experience. It allows for better inventory management, real-time monitoring of product availability, targeted advertising, and easy access to customer support.

Conclusion

The research has successfully designed and implemented an IoT-based vending machine management system with advanced functionalities. The system enables comprehensive monitoring and management of vending machines, offering real-time insights into sales data and facilitating data-driven decision-making. The integration of IoT technology allows for enhanced operational efficiency and customer satisfaction. By leveraging geographical location information, the system provides convenient options for users when certain goods are sold out, suggesting nearby vending machines with similar products. Furthermore, the remote advertising management feature enables efficient and targeted advertisement campaigns. Overall, this research contributes to the advancement of vending machine technology, offering improved functionality, intelligence, and convenience to both operators and users. Future enhancements may involve incorporating additional IoT features and expanding the system's capabilities for further optimization and innovation.

Reference

1. Dimitris, M., Ekaterini, V., & Zogopoulos, V. (2017). An IoT-based Platform for Automated Customized Shopping in Distributed Environments. *Procedia CIRP*, 72, 892-897. <https://doi.org/10.1016/j.procir.2018.03.199>
2. Murena, E., Sibanda, V., Sibanda, S., & Mpofu, K. (2019). Design of a Control System for a Vending Machine. *Procedia CIRP*, 91, 758-763. <https://doi.org/10.1016/j.procir.2020.04.136>
3. Singh, K., Arora, G., Singh, P. et al. IoT-based collection vendor machine (CVM) for E-waste management . *J Reliable Intell Environ* 7, 35–47 (2021). <https://doi.org/10.1007/s40860-020-00124-z>
4. Jaafar, A. ., & Mohd, M. N. . (2022). Smart Vending Machine Counter using IoT. *Evolution of Information*,

- Communication and Computing System, 2(1), 63–75. Retrieved from <https://publisher.uthm.edu.my/books/eries/index.php/eiccs/article/view/28>
5. Dash, S., Prusty, D. (2021). Domain-Specific IoT Applications. In: Kumar Pani, S., Pandey, M. (eds) Internet of Things: Enabling Technologies, Security and Social Implications. Services and Business Process Reengineering. Springer, Singapore. https://doi.org/10.1007/978-981-15-8621-7_3
 6. Kim, T., Ramos, C., & Mohammed, S. (2017). Smart City and IoT. Future Generation Computer Systems, 76, 159-162. <https://doi.org/10.1016/j.future.2017.03.034>
 7. D. Minoli, K. Sohraby and B. Occhiogrosso, "IoT Considerations, Requirements, and Architectures for Smart Buildings—Energy Optimization and Next-Generation Building Management Systems," in IEEE Internet of Things Journal, vol. 4, no. 1, pp. 269-283, Feb. 2017, doi: 10.1109/JIOT.2017.2647881.
 8. Bingyuan Wang, Yuxiao Xie, and Xiaohui Duan. 2021. An IoT Based Fruit and Vegetable Sales System: A whole system including IoT based integrated intelligent scale and online shop. In Proceedings of the 2021 5th International Conference on Cloud and Big Data Computing (ICCBDC '21). Association for Computing Machinery, New York, NY, USA, 109–115. <https://doi.org/10.1145/3481646.3481663>
 9. Mishra, K.N., Chakraborty, C. (2020). A Novel Approach Toward Enhancing the Quality of Life in Smart Cities Using Clouds and IoT-Based Technologies. In: Farsi, M., Daneshkhah, A., Hosseinian-Far, A., Jahankhani, H. (eds) Digital Twin Technologies and Smart Cities. Internet of Things. Springer, Cham. https://doi.org/10.1007/978-3-030-18732-3_2
 10. G. Phade, A. Tribhuvan, O. Vaidya and S. Gandhe, "Design and Development of Smart Personal Protective Equipment Vending Machine using Internet of Thing," 2021 International Conference on Emerging Smart Computing and Informatics (ESCI), Pune, India, 2021, pp. 252-257, doi: 10.1109/ESCI50559.2021.9396775.