

## IoT-based Coin Slot of the Vending Machine

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### Abstract

This work introduces a comprehensive Internet of Things (IoT)-based system to revolutionize traditional vending machine operations. The focal points of this endeavor include the utilization of the Blynk Application for real-time notifications to service personnel, facilitating proactive maintenance and repair actions specific to coin slot issues. The hardware implementation will be orchestrated through an ESP32 microcontroller, augmented with GPS functionality, seamlessly integrated into the overarching IoT platform. This amalgamation aims to provide precise location tracking and enhance the overall monitoring capabilities of the vending machine. Moreover, the system employs an image and infrared sensor to identify and record objects within the coin slot, contributing to an intricate understanding of potential issues. This holistic approach seeks to elevate vending machine management, offering a paradigm shift towards intelligent, responsive, and efficient systems within the context of emerging IoT technologies.

## 1. Introduction

A vending machine is a mechanical device that delivers goods to customers once they input money, tokens, or pay digitally. Vending machines are intended to give consumers a quick and automated means to access a wide range of items, such as food, beverages, cigarettes, toiletries, and more, without the need for human involvement (A. Taflove and M. E. Brodwin, 1975). The vending machine can be categorized into product-oriented and service-oriented machines (A. Taflove and M. E. Brodwin, 1975). However, the traditional operation of vending machines has remained relatively unchanged over the years, relying on coins, tokens, or bills for transactions. In recent times, the emergence of the Internet of Things (IoT) has brought about a new era in vending machine management and user experience. IoT applications are required to keep track of the environment, spot issues, communicate, and address issues without the need for human intervention (R. F. Harrington et al., 1989). Therefore, as a result, it may access real-time data gathering, raise sales, improve operational efficiency, and offer things to customer demand, which determines the consumer desire by which selected regular items are supplied (A. F. Oskooi et al., 2008). The idea behind this work is to create a system that can be wirelessly monitored on an IoT platform server. Because an Arduino board is less expensive and more convenient to connect to the sensor, this setup employs one. The system can keep track of things like whether or not something is trapped in the coin slot of the vending machine. The sensor then transmits data and pictures back to the sensor.

Vending machine transactions are considered standard purchasing scenarios. In these situations, customers make their selections without needing assistance or any tools offered by the establishment. If the purchase process proceeds smoothly, the customer's needs are promptly addressed (R. Holland, 1977). When faced with a challenge, customers must figure out how to deal with the situation, with the primary concern revolving around the payment process. Coin slots can experience occasional blockages, particularly when foreign objects are introduced into

them (B. Engquist et al., 1977). Customers may call and report any difficulties with the vending machines using the phone number often placed on a sign connected to the machines. Any faults can then be quickly fixed. Customers risk leaving the vending machine without making their desired purchase if this happens (A. F. Oskooi et al., 2008). The vending machine owner can incur financial losses if customers do not make any purchases. This issue can be addressed by implementing IoT technology, where the vending machine communicates its status and allows for repairs, ensuring efficient operation and potential profit preservation.

The vending machine system is famous worldwide and thus is very convenient and indispensable for people (Z. P. Liao et al., 1977; R. Wu et al., 2002). Researchers have proposed new ideas and implementations for vending machine systems (B. K. Huang et al., 2003; K. Xiao et al., 2004). This article aimed to propose a smart vending machine system combining deep learning and machine learning technologies to deliver smart vending services. Tensorflow technology is used in the smart vending machine system that has been presented to determine the sorts of items placed into the coin slot. Additionally, ESP32 is utilized as an embedded system to retrieve the items that have been stuck. The system that is being suggested gathers the vending picture record at the coin slot to determine the kind of item that is trapped in the coin slot system.

The coin slot vending machine is a machine that has been particularly designed to distribute a wide variety of products or services in exchange for monetary units in the form of coins. It is a mechanism that is extensively used and efficient, and it has been designed to distribute these items. The presence of these machines is commonplace in a variety of settings, such as retail enterprises, laundromats, arcades, and transit stations, among others. There is not much complexity involved in the working mechanism of a vending machine that collects coins. Users must place coins into a specific slot corresponding to the product or service they may be interested in purchasing. Immediately after the payment procedure has been completed, the machine will dispense the chosen item. The fact that coin slot vending machines have a transaction procedure that is both efficient and effective makes them a practical alternative for organizations that are looking to automate sales operations and increase consumer accessibility.

Vending machines provide a wide variety of items, such as food, drinks, tickets, and critical supplies, allowing them to satisfy a wide range of customer requirements. Because of this, consumers can have a shopping experience that is both convenient and easy to complete. In recent years, there has been a notable rise in the number of people using various forms of electronic payment. Coin slot vending machines, on the other hand, continue to exist and thrive because they provide a trustworthy and user-friendly option for transactions that are both quick and easy.

## 2. Methodology

The block diagram in Fig. 1 consists of seven blocks that relate to the system of the project. This sub-section will explain each of the blocks.

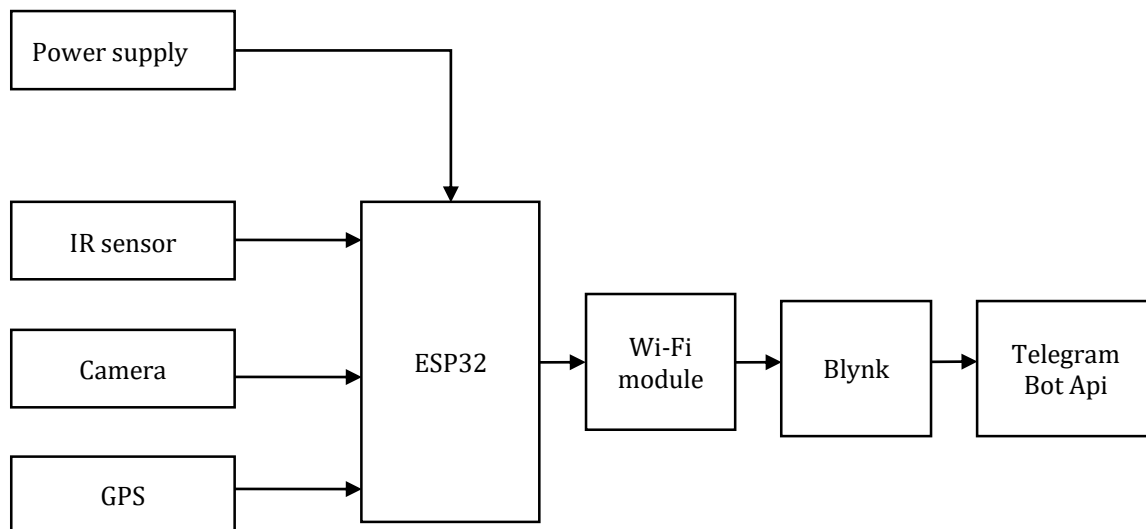
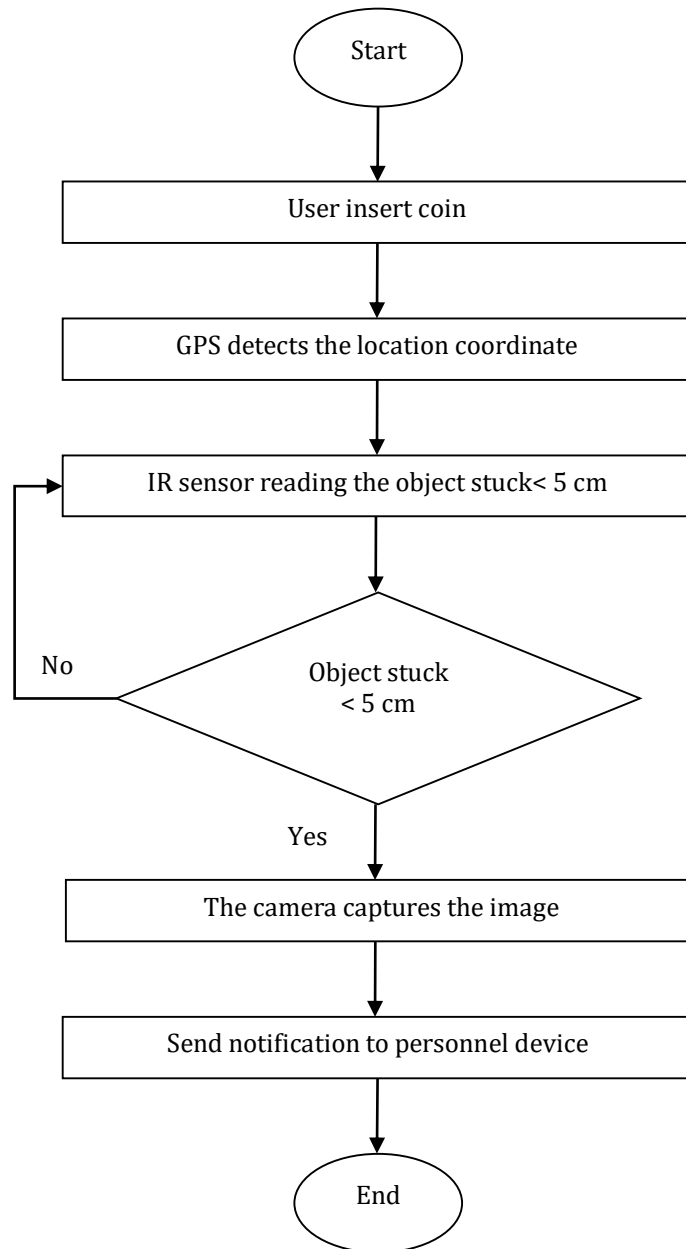


Fig. 1 The block diagram of the notification system

The flow chart for the project is shown in Fig. 2. Users must first insert a coin into the coin slot, which initiates GPS tracking. The maximum distance of an item that the system can detect is not less than 5 centimeters. The IR sensor will detect an impediment inside the coin slot if an item is larger than this threshold. The camera will take a picture of the object blocking the view once detected. The IoT application will simultaneously produce a notification, instantly informing the owner of the vending machine to take appropriate action. By using an integrated method, the vending machine's internal obstacles are handled effectively and automatically, improving overall operating reliability.



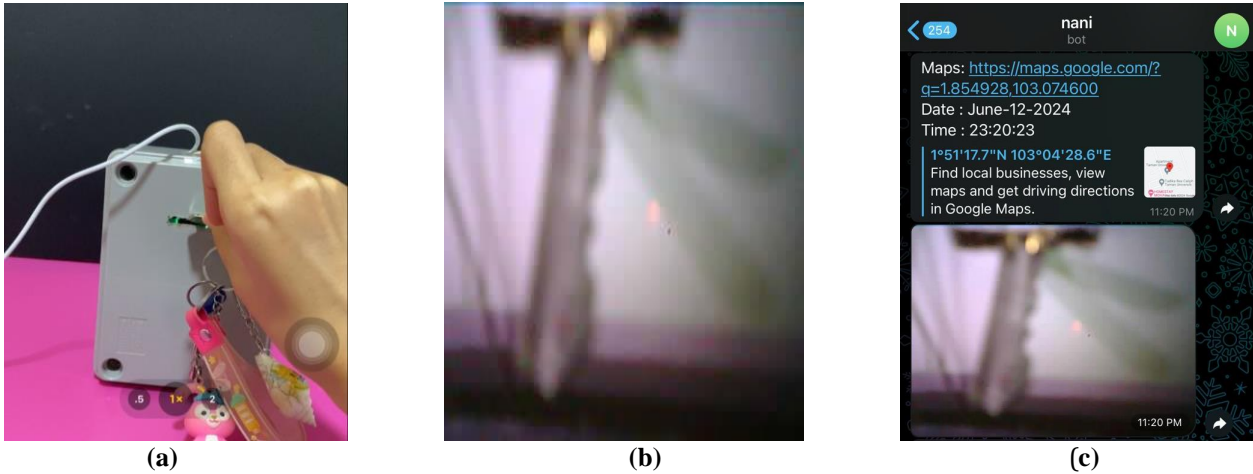
**Fig. 2** Developing vending machine hardware development flowchart

### 3. Results and Discussion

The main objective of this chapter is to develop an IoT-driven system for identifying obstructions within the coin slot of a vending machine using image recognition technology. Additionally, this chapter will assess the prototype's performance and usability. Results acquired during the project's performance analysis are the subject of this chapter. Several experiments and tests were conducted to evaluate the system's reliability. The endeavor is comprised of the integration of software and hardware. Once the coding has been executed, the Arduino IDE will display the system. As a result, the system will display the data obtained from the server, and the server will receive a notification message.

### 3.1 Hardware Result

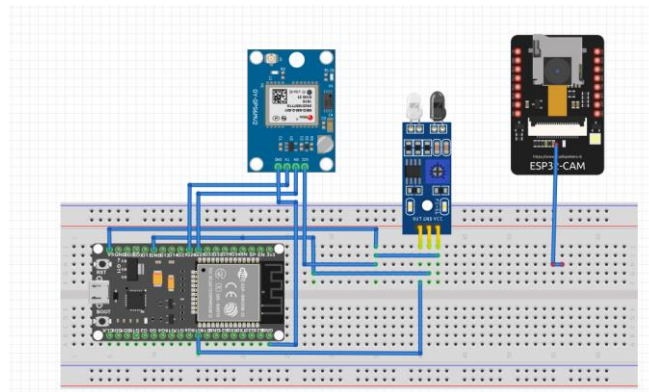
Fig. 3(a) and 3(b) illustrate the IR sensor detection system. The IR sensor illuminates and the system is prepared for operation when the ESP32 is connected to the power supply. An image of an object that is trapped is displayed by the Telegram Bot in this figure. This implies that the IR sensor must be situated at a distance of less than 5 cm from the object to detect it. Fig. 3(c) shows Image and location notifications to the Telegram Bot API when the IR sensor triggers an object stuck.



**Fig 3** (a) The image of a key inserted into the coin slot; (b) the image of the key captured by the ESP32-CAM; (c) Image and location notifications to the Telegram Bot API when the IR sensor triggered an object stuck

### 3.2 Circuit Design and Software Design

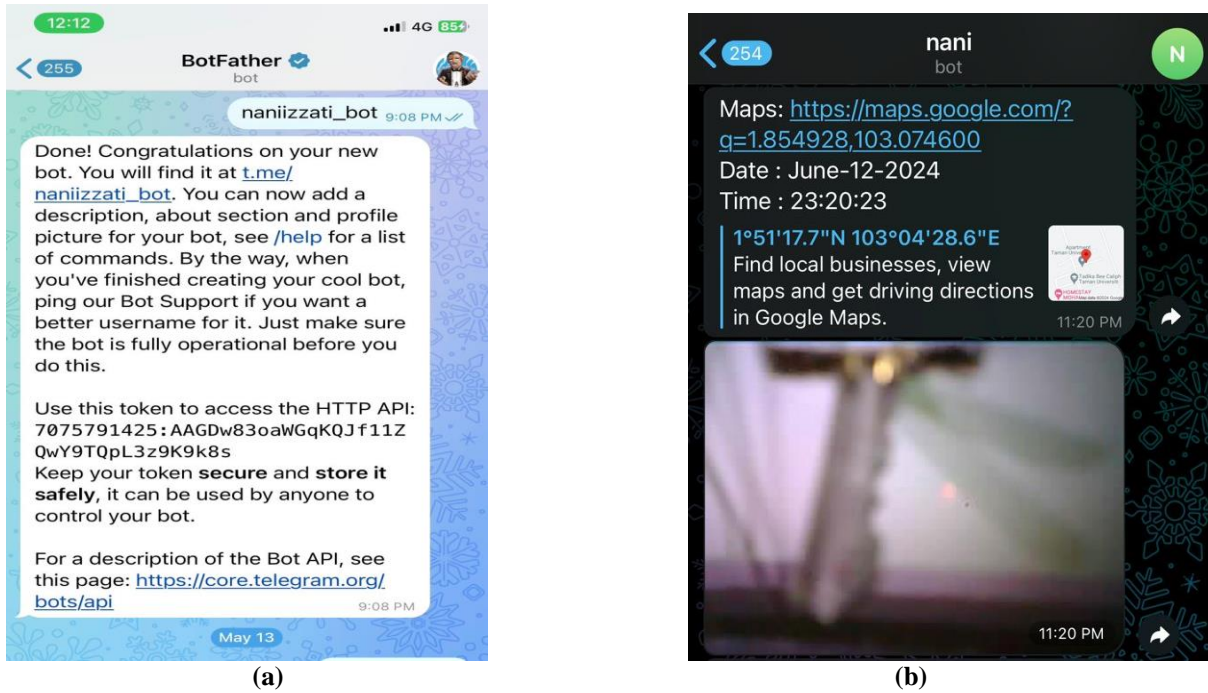
Fig. 4 shows the Fritzing program was used to construct the layout of the object detector. All of the components that are interconnected to carry out the multi-hand identification function are displayed in the diagram. These components include the ESP32, the ESP32Cam, the GPS module, and the infrared sensor. All of the other elements are managed by the ESP32, which acts as the primary microcontroller board. A connection is made between the ESP32 and the infrared sensor, which is used for object detection. With the integration of an ESP32, the image or results may be shown graphically. It is possible to track and log readings using GPS modules, which are used for location tracking and recording. Several colored wires, which symbolize the three sorts of connections (power, ground, and signal), are used to establish the connections.



**Fig. 4** The circuit design for prototype

Fig. 5(a) Channel shown in personnel device application, The Telegram Bot API was integrated to send notifications to users when an object is detected in the coin slot. This feature ensures that users are promptly informed of any obstructions, enabling quick resolution. Fig. 5(b) illustrates the notification received via the Telegram bot, and Fig. 5(b) illustrates the specific image of the trapped object and which vending machines required maintenance. The widget configuration transmits the information to the vending machine proprietor when the coin slot of the vending machine detects a stuck object. In addition, the vending machine proprietor can

view the image of an object that is lodged in the coin slot of the vending machine, as well as its location mapping. The chat will indicate when an object becomes trapped in the coin slot.



**Fig. 5** (a) Channel shown in personnel device application; (b) illustrates the specific image of the object that was trapped and which vending machines required maintenance

The following interface to be discussed is the display of the picture captures taken by the ESP32Cam, as well as the distance between the infrared sensor and the object. The distance is determined by the different types of objects that are trapped in the coin slot. The image will be automatically transmitted to the telegram whenever the infrared sensor identifies an object less than 5 cm. IR sensors cannot detect images if there is a distance of more than 5 cm between the object and the sensor. Following the prototype of the project, the distance may be altered. Table 1 displays the types of objects and the distance between the infrared sensor and the object.

**Table 1** Types of objects stuck and the distance between IR sensor

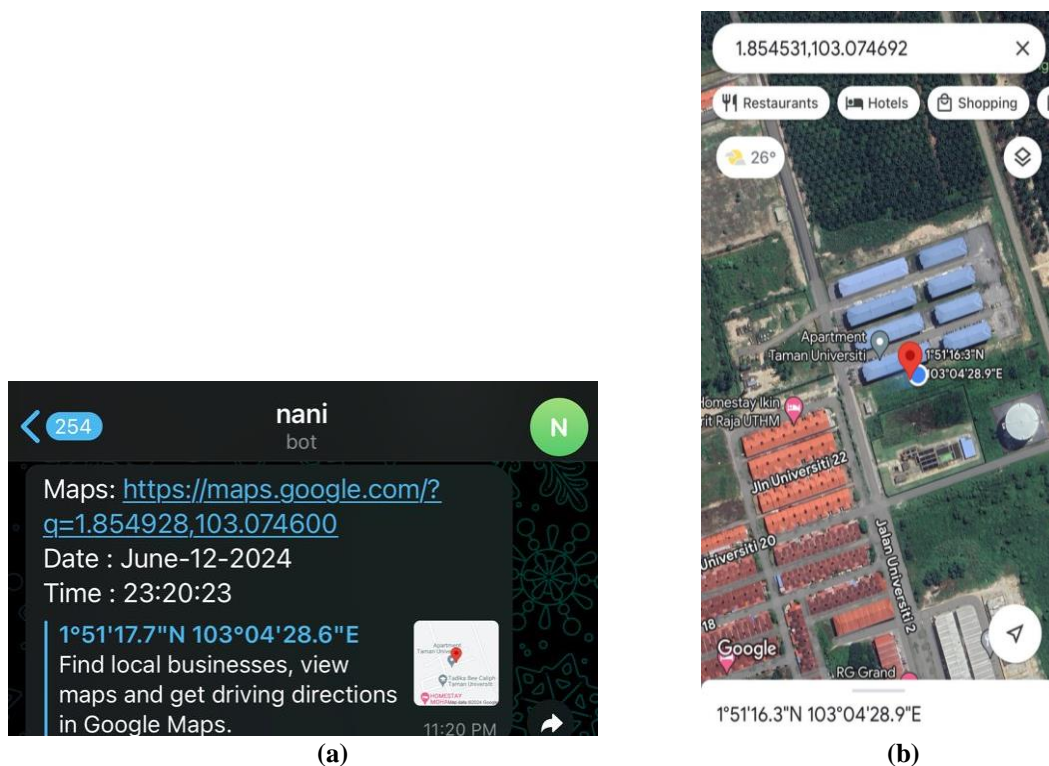
The object stuck	Distance between IR sensor (cm)	IR sensors detect an object
Key	2.6	Yes
wire	1.8	Yes
Paper	1.0	Yes
scissor	0.9	Yes
ATM card	3.9	Yes

Fig. 6 illustrates the format of the alert notifications that are sent to users. When the coin slot of the vending machine detects a stuck object, the widget setting sends the information to the vending machine owner. Aside from that, the vending machine owner may view the position of the vending machine when they visit the Blynk, and the dashboard will show which lane has to be fixed when an object becomes trapped in the coin slot.



**Fig. 6** Display shown in personnel device application for the user

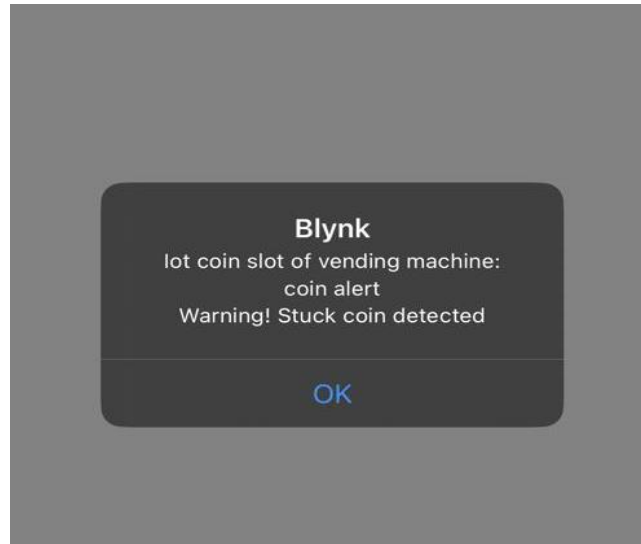
Furthermore, as shown in Fig. 7(a), The system is designed to integrate hardware components for telegram notifications and GPS location tracking with an IR sensor for object detection. When the IR sensor detects alcohol, it triggers the ESP32Cam. The ESP32Cam then sends a telegram notification to the user's mobile phone. This report reads, "Warning! Stuck coin detected" This message is included. Along with an object detected and GPS coordinates (latitude and longitude) of the location where the place of the vending machine was found, the GPS provides an accurate location of the user. This system is a complete solution for real-time detection and location tracking.



**Fig. 7** (a) Navigation link; (b) Google Maps

Overall, the alert system is a key component of the device's functionality, providing timely and accurate notifications to the owner of the vending machines.

Fig. 8 illustrates the Blynk application as accessed via a smartphone. Blynk is an IoT platform that allows users to monitor and control their connected devices through a user-friendly mobile interface.



**Fig. 8** Blynk application via phone

#### 4. Conclusion

In conclusion, the implementation of image recognition technology has proven to be a feasible solution for identifying obstructions within the coin slot of a vending machine. This technology leverages IoT principles, allowing for real-time monitoring and data analysis. The system's ability to recognize and respond to obstructions enhances the overall efficiency and reliability of the vending machine. The primary goal of this system is to identify objects present through an IoT platform that monitors the coin receptacle. The objectives have been satisfactorily achieved and implemented in this endeavor. The device sends an image through the personnel device to notify the object present, utilizing an IoT platform. The project utilizes the Telegram Bot API and Blynk to display notifications, images, and location information on a mobile phone for informational purposes. The Arduino IDE, which functions as the coding platform for the microcontroller board, executes and supports these implementations.

The outcomes of this research have significant implications for vending machine technology and IoT applications. The integrated system not only addresses the identified challenges related to coin slot obstructions but also introduces innovative features that contribute to the overall advancement of vending machine functionalities. The GPS functionality enhances logistics and monitoring, while image notifications provide valuable insights and immediate responses to potential issues.

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#### Conflict of Interest

The authors declare that there is no conflict of interest regarding the paper's publication.

#### Author Contribution

The authors attest to having sole responsibility for the following: planning and designing the study, data collection, analysis and interpretation of the outcomes, and paper writing.

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