



# DESIGN AND DEVELOPMENT OF SMART VENDING MACHINE

**Prof. Vijaykumar Patil, Prof. Sandesh Sangale**

**Abhishek Gangane, Shrinikeet Rajmane, Aditya Abhang, Samiran Shinde, Devendra walawalkar,  
Mentors, and Students**

Kolhapur Institute of Technology's College of Engineering, Kolhapur, Maharashtra, India  
Department of Electronics and Telecommunication Engineering  
Department of Mechanical Engineering

## ABSTRACT

The project aims to design and develop a Smart Vending Machine to improve accessibility of medical products in rural areas. The machine integrates web socket technology, a QRcode mechanism, a secure transaction gateway, and an ESP32. It features user-centric features, modern payment options, and a motor-driven mechanism for accurate product dispensing.

**Keywords:** WebSocket Technology, Razorpay, Vending Machine, Web Browser, LVGL, stepper motor

## 1. INTRODUCTION

Vending machines have revolutionized the retail trade industry by providing a convenient and efficient way to access a wide array of products, whether they be food or non-food items. These machines typically operate by delivering products using spirals and then dispensing them into a delivery pan located at the machine's bottom. Customers can easily select their desired product, retrieve it, and make payment on the spot, whether through cash, credit card, or online payment methods.

In modern retail environments, vending machines have become a common sight, offering a seamless shopping experience. However, while these machines excel in providing everyday items, they often struggle to dispense essential medical supplies, particularly in remote or rural areas where healthcare accessibility is limited. To address this challenge, a new concept of Smart

Vending Machines specializing in medical supplies is being introduced. This innovative approach incorporates advanced features such as QR codes, web socket technology platforms, and motor-driven dispensing mechanisms to improve the availability and accessibility of crucial medical products in underserved communities. By combining cutting-edge technology with practical solutions, this project aims to make a positive impact on healthcare delivery systems.

This project will dive into a comprehensive analysis of current vending machine technologies, identify the existing problem statement regarding medical supply distribution, and outline the key objectives and scope of this transformative endeavor. Through this exploration, we seek to pave the way for a more inclusive and efficient system that caters to the unique needs of remote and underserved populations.

## 2. PROBLEM STATEMENT

In rural areas there are limited store houses or no stores at all making it difficult for residents to obtain necessities. Traditional vending machines lack sophistication needed to deliver vital commodities because they are primarily made for non-perishable goods.

## 3. LITERATURE REVIEW

Arduino has been used to implement any time vending machine, without any assistance from a human, this device is capable of retrieving the medications and making medicines available to everyone, this medical vending machine has undergone various tests and prototypes developed successfully<sup>[1]</sup>.

The automatic vending machine is technically feasible to the people. The atmega16 controller serves its foundation. It provides constant access to medications even in remote places. It plays major roles in hostel areas, railway platforms and in rural areas<sup>[6]</sup>

The proposed system is the design of a finished model of IOT based sanitary napkin machine with digital payment and it is able to maintain exhaustive stocks of goods inside vending machines. The IOT enabled features ensures the real time information with detailed reports of dispensed sanitary pads and particular amounts of it<sup>[9]</sup>.

The machine material sound was dictated by surrounding the alarm system and fingerprint are foundations of machines safety and security, this machine is user friendly since it gives vendors a platform to advertise through internet platforms<sup>[2]</sup>.

## 4. DESIGN AND OBJECTIVES

To design vending machine following are the steps to be followed ;

1. To create websocket technology and add payment gateway to it.

2. Giving signal to machine to dispense specific product id.
3. Motor will give rotation to stationary compartment (attached to belt drive or motor)
4. It will rotate and fall down in tray from where customer could receive a product
5. After dispensing a product it will display a successful message .

## 5. METHODOLOGY

### Case 1

In a traditional vending machine, you choose your item and then pay for it, you then indicate how much item you would want. Every product is kept inside the machine in a compartment with a motor and spring system that are specific to its weight and size. The motor spins a certain number of times after you choose the quantity, which activates the spring and forces the products in forward direction. The object drops in the dispensing area as a result you can retrieve it, essentially it's a process where your selection triggers a mechanical system to deliver the product you have paid for it.

Our proposed mechanism follows of gum ball machine that operates through effective mechanism. When you insert a coin initially you are triggering series of event inside the machine, it include metal spiral chute, dispenser, as you turns the handle rotates scooping up a gumball from the reservoir at the top, as it spiral down flap prevents it from falling out immediately. Once you release the handle, the release mechanism opens the flap momentarily, allowing the gumball to drown into the chute.



FIG 1 : PROTOTYPE

This simple mechanism of dispensing is used in our proposed model. In the proposed mechanism of vending machine there is compartment attached to belt drive and motor, as it gives signal to dispense specific product id eventually motor start rotating and product will fall down in tray from where customer could receive product and after dispensing it will a message of dispensing a successful message on display. To carry out this entire mechanism STM32 microcontroller is used, it comes in different processing capabilities allowing vending machines to handle tasks such as user interface, payment processing etc. Offers a combination of processing power, peripheral integration, energy efficiency, security features, real time performance and enabling robust and reliable operation in various deployment scenarios.

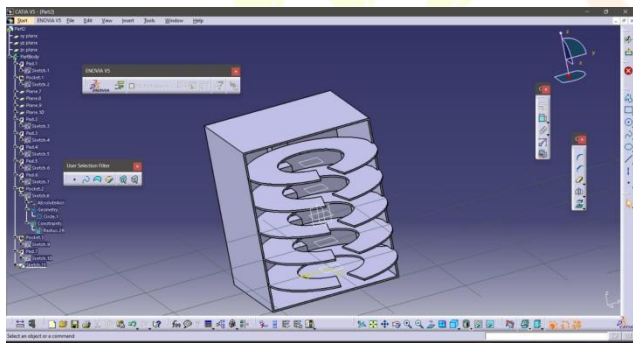


FIG 2 : CASE-1 MODEL

A payment gateway with dynamic qr code simplifies vending machine transactions, enabling secure payment based options. When customer scans this code with their smart phone, the payment information is securely transmitted to payment gateway which then processes the transaction, as it eliminates the need for physical cash or card payments.

The LVGL (light and versatile graphics library), a tool used here for the user interface of vending machines, it provides drags and drop functionality simplifying graphical interface development for vending machine. Its user friendly drag and drop specification allows developers to easily design and customize interfaces without extensive coding knowledge, additionally it offers features such as

customizable widgets, animation, event handling, enhancing the user experience, streamline payment process, and ensures efficient interface design for vending machine.



FIG 3 :STM32 AND LVGL  
(<https://lvgl.io/developers>)

The V Belt drive mechanism is used as it provides reliable and product dispensing, efficient power transmission and reducing energy loss. The design enables smooth operation, minimizing wear and tear on components. This drive system is cost effective and easy to implement, Making its perfect choice for vending machines guaranteeing dependable and trouble-free dispensing processes.

SR. NO	COMPONENT
1.	STM32(with touch-screen display)
2.	Motors
3.	V belts
4.	couplers
5.	SMPS

Table 1: Case -1 components

**CASE -2** (final design and implementation):

The dispensing mechanism of our vending machine has been updated from the V belt drive system to a system resembling a pen-pencil vending mechanism. This modification lowers the possibility of product damage during dispensing and height restrictions. The new mechanism ensures gentle handling and reduces the possibility of things getting damaged during the dispensing process by using simpler and more efficient ways for product distribution.

Using this strategy overall improves the user experience by offering vending solutions that are more dependable and cost effective, with this upgrade vending machine can accommodate a wider range of products while maintaining product integrity and ensuring customer satisfaction.



FIG 4 : PROPOSED MODEL

The coupler is connected between dispensing mechanism and motors, Which streamlines operation and improves dependability by ensuring strong connection between this two parts, it lowers the possibility of malfunction and requires less maintenance it increases the vending machine productivity and product handling by simplifying the setup. Overall use of this coupler provide practical and effective solution ensuring reliable operation and customer satisfaction .

Basically it highlights the potential of ESP32-based systems for controlling and monitoring. It also integrates with payment systems allowing customers to make cashless transactions and also it operates reliably while consuming minimal power. This is important for vending machine to

be deployed in remote or off-grid location where power sources are limited, it also can check inventory levels and monitors function without being present physically. This module support TCP/IP capability and microcontroller access any wifi network provides solution to all requirements such as cost, power, performance and design.

The ESP-IDF (Express IoT Development framework) is a software platform used in vending machine to develop application for ESP 32 microcontroller, its features includes robust networking capabilities, low power consumption, and support for various peripherals. Understanding of ESP-IDF is crucial for vending machine as it enables developers to create reliable and efficient vending machine softwar. A thorough understanding of its characteristics guarantees the efficient use of ESP 32 microcontroller, which improves vending machine performance and user experience.

Stepper motor of Nema 17 is used for this machine for precise control over movements and allowing for accurate dispensing of specific items in vending machines.

(A) Each step corresponds to a specific rotating angle, enabling precise positioning of the dispensing mechanism .

(B) High torque : offers high high torque even at slow speeds. This torque is crucial for driving mechanism and also responsible for dispensing items, Especially those items which are heavy or require significant force to move.

(C) Easy integration : These motors are widely used and are compatible with various mounting options and accessories, Making them easy to integrate into vending machine

(D) Bi-directional control : Stepper motors can rotate in both clockwise and counterclockwise direction, allowing for bidirectional movements of the dispensing mechanism. The flexibility can be beneficial in vending machines that require dispensing in different directions or configurations.

(E) Closed loop control : It provides feedback on the motors positions. This feature ensures more precise positioning and can help prevent errors or stalls in the dispensing process. The use of nema

17 stepper motor can contribute to efficient, reliable and enhancing user experience and optimizing maintenance and management processes.

**(Advancement in case-1)**The razorpay API offers a guide for integrating digital payment with razorpay API, one can enable various payment methods including credit/debits cards, net banking, UPI and wallets, enhancing customer convenience. The API supports dynamic QR code generation allowing vending machines to generate unique codes for transactions, facilitating secure and efficient payment via smartphones. Additionally Razorpay API ensures security compliance and seamless integration with vending machine software.

The vending machine’s user interface was previously controlled by an STM32 microcontroller with an LVGL, But system is now managing payment alternatives via websocket technology more precisely, An ESP32 facilitating communication between vending machine and user. This implies that instead of interacting with the vending machine’s interface directly, users can now access through mobile browsers. We have designed schematics for stepper motor control using A4988 motor driver, ensuring precise and efficient motion control.

the capabilities with current regulation, step time, and microstepping features while enhancing machine functionality and overall efficiency.

**(Mechanical advancement)** The funnel-type compartment where the product are stored. The slotted wheel located at the bottom of the mechanism rotates according to the requirements and dispenses the product. But the greatest problem with this kind of mechanism is that the products are very light, so they get stuck at the opening of the funnel.

To overcome this problem, we have introduced a vibrating type of mechanism inside the funnel, which makes a narrow passage so that the product will move in a single line. Now to operate this vibrating mechanism, the drive is given through the motor itself, which is the rod extended from the wheel. The driving mechanism is similar to the wiper mechanism of a car or bus. The vibrating mechanism simply consists of a cam and follower.

As mentioned earlier, the drive to the cam is given by the motor, which will rotate with the rotation of the wheel, and the follower is a simple triangular-shaped device that moves to and fro with the movement of the cam.

So then the particular brand is selected, the signal is given to the motor of the particular compartment, and then it is checked whether the quantity given is available or not. If the quantity is available, the motor starts moving, and the motor is connected with a coupler to the slotted wheel, which will rotate with the motor and dispense the required amount of product. At last, there would be a sensor that would verify whether the product is dispensed or not, and if in a given particular time the product is not dispensed, the money of the customer will get automatically reverted.

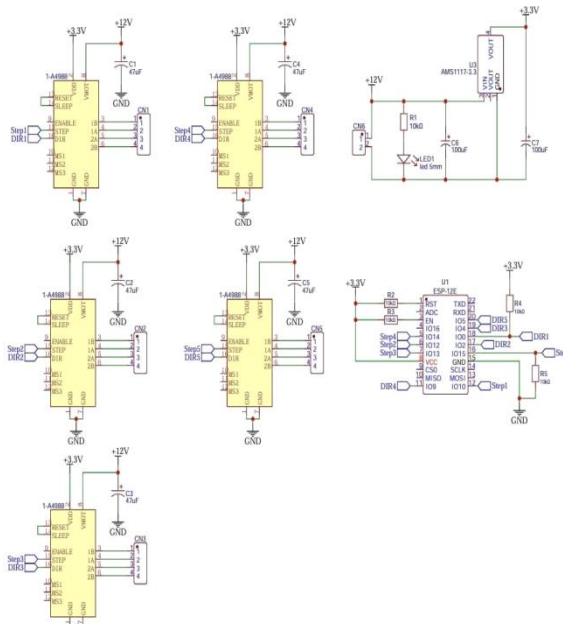


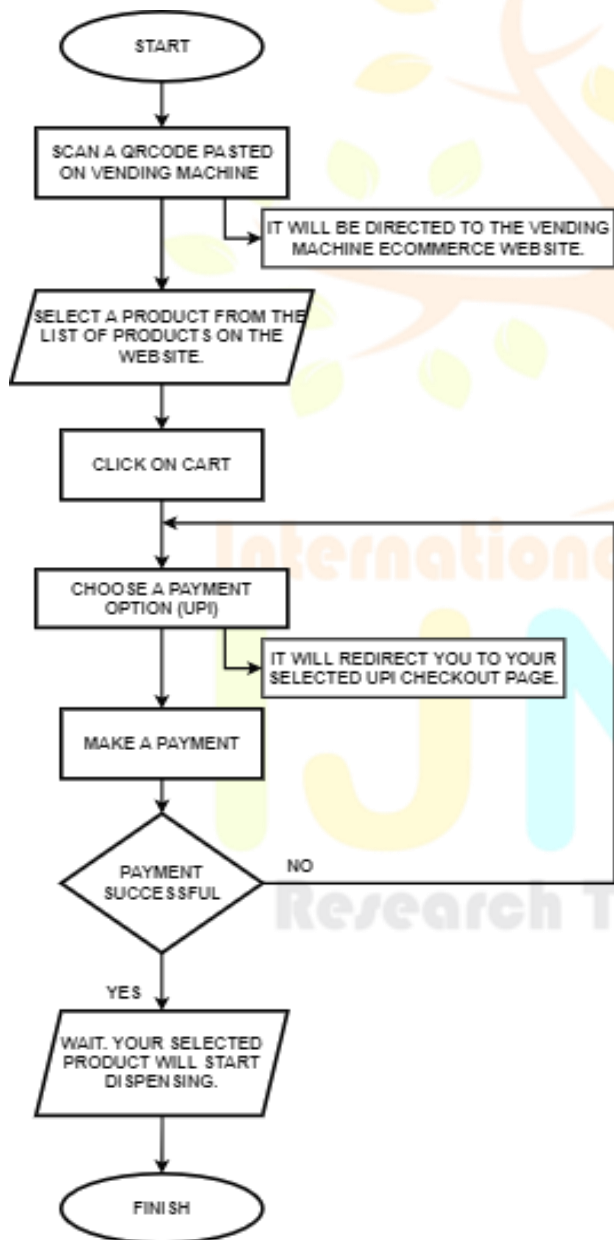
FIG 5 : PCB SCHEMATIC

The A4988 motor driver plays a crucial role in vending machine operation, regulating power and ensuring precise movements, the driver enhances

SR NO	COMPONENTS
1	Nema 17 stepper motor
2	A4988 motor driver
3	Coupler
4	ESP32
5	12-24V SMPS

Table 2: Case - 2 components

**Flowchart:**



**6. RESULTS AND DISCUSSION**

The Smart Vending Machine brings crucial supplies to rural areas. Using technology like QR codes and mobile browsers makes it easier for people to buy what they need. The machine's new design ensures items are dispensed safely and accurately, preventing damage. It's more reliable and needs less maintenance because of advanced systems like the ESP32.

Payment is simple too, with options like credit cards and mobile wallets. Safety features like sensors also make sure customers get what they pay for.

Overall, these vending machines are a big step in making sure everyone, no matter where they live, can access the supplies they need. In the future, we can make them even better by adding features like predicting when they need maintenance and using some innovative things.

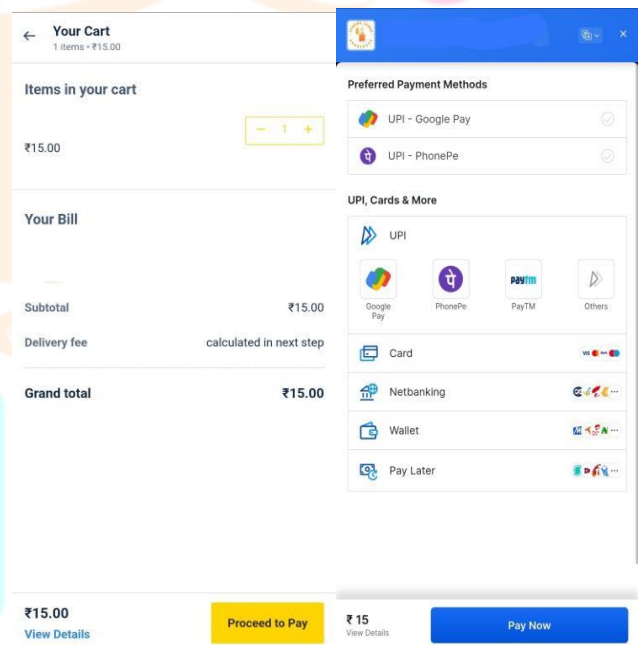


FIG 6. Payment Checkout page

## 7. CONCLUSION

In rural and underserved areas, the Smart Vending Machine for Medical Products is a big step in enhancing access to necessary health care supplies. It combines mechanical systems with web-based technologies to provide a comprehensive response to the short comings of traditional distribution channels, especially in places with a dearth of medical supply stores.

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