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**DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

# **Sanitary Pad Dispenser**

*Design Thinking Lab Report*

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RV College of Engineering

**In partial fulfillment of the requirements for the degree of**

**Bachelor of Engineering**

**in**

**Electronics and Communication Engineering**

**2022-2023**

# RV COLLEGE OF ENGINEERING®, BENGALURU-59

*(Autonomous institution affiliated to VTU, Belagavi)*

## Department of Electronics and Communication Engineering



### CERTIFICATE

Certified that the Design Thinking Lab project titled '**Sanitary Pad Dispenser**' is carried out by **Kavyanjali K(1RV21EC080)**, **Uby H(1RV21EC180)**, **Aditya Joshi(1RV21EC008)**, **Sourish G (1RV21EC167)**, who are the bonafide student of RV College of Engineering, Bengaluru, in partial fulfillment of the requirements for the degree of Bachelor of Engineering in Electronics and Communication Engineering of the Visvesvaraya Technological University, Belagavi during the year 2022-2023. It is certified that all corrections/suggestions indicated for the Internal Assessment have been incorporated in the Design Thinking Lab report deposited in the departmental library. The Design Thinking Lab report has been approved as it satisfies the academic requirements in respect of Design Thinking Lab work prescribed by the institution for the said degree.

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Name of Examiners

Signature with Date

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2.

## **DECLARATION**

We, **Kavyanjali K(1RV21EC080)**, **Uby H(1RV21EC180)**, **Aditya Joshi(1RV21EC008)**, **Sourish G (1RV21EC167)**, students of fourth semester B.E., Department of Electronics and Communication Engineering, RV College of Engineering, Bengaluru, hereby declare that the Design Thinking Lab project titled '**Sanitary Pad Dispenser**' has been carried out by me and submitted in partial fulfilment for the award of degree of **Bachelor of Engineering in Electronics and Communication Engineering** during the year 2022-2023.

Further, we declare that the content of the report has not been submitted previously by anybody for the award of any degree or diploma to any other university.

I also declare that any Intellectual Property Rights generated out of this Design Thinking Lab carried out at RVCE will be the property of RV College of Engineering, Bengaluru and we will be one of the authors of the same.

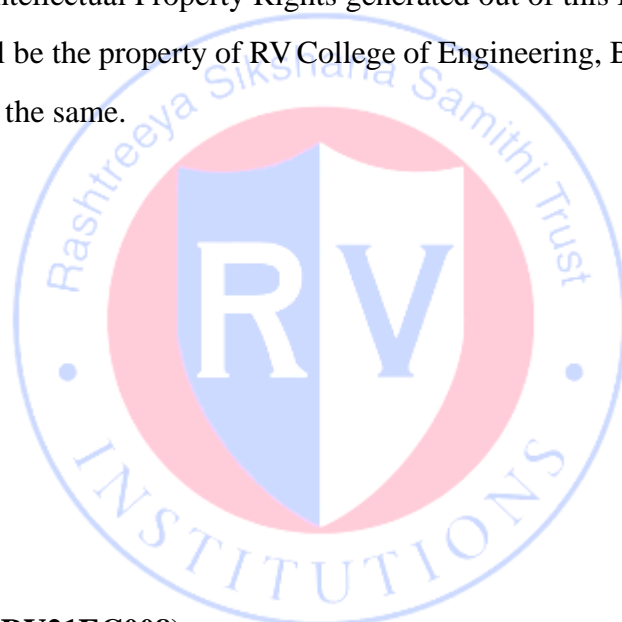
Place: Bengaluru

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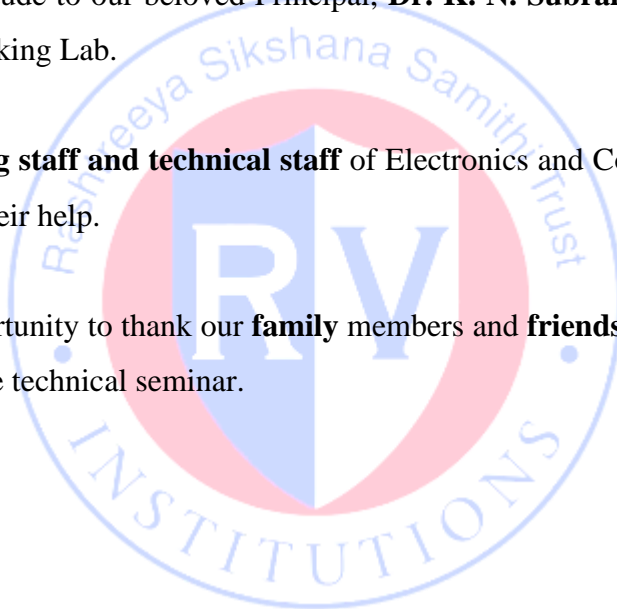
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## ABSTRACT

The provision of adequate menstrual hygiene products is a fundamental yet often overlooked aspect of women's health and well-being. In many parts of the world, women and girls face significant challenges accessing sanitary pads, leading to discomfort, embarrassment, and potential health risks. This project endeavors to address this pressing issue by designing and implementing an IoT-based Sanitary Pad Dispenser integrated with a custom-made website for online payment processing.

The project's inception was rooted in a deep understanding of the challenges faced by female college students in accessing sanitary pads within their educational institution. Through an empathetic survey, we garnered insights into the urgent need for a convenient and accessible solution. The responses underscored the significance of convenience, affordability, and the elimination of the stigma associated with menstruation.

The IoT-based Sanitary Pad Dispenser operates through a user-friendly website, allowing users to create accounts, make online payments, and receive sanitary pads in a discreet and dignified manner. The integration of IoT technology ensures real-time inventory management, minimizing wastage and ensuring that sanitary pads are consistently available.

This project's impact extends beyond convenience; it promotes gender equality, financial equity, and better menstrual hygiene practices. By providing accessible and affordable sanitary pads, it empowers women to participate fully in education, work, and social activities, ultimately contributing to a more equitable society. The project embodies the transformative potential of technology in addressing critical social issues, making a tangible difference in the lives of women and girls.

Furthermore, the project's implementation encompasses a robust and scalable software model that integrates Node.js, HTML, CSS, and the MQTT protocol. This dynamic system streamlines order processing, enhances user experience, and ensures real-time communication between the website and the dispenser. The project's future scope includes expanding its reach to serve a broader community, potentially integrating government subsidies, and incorporating sustainable practices in the production and distribution of sanitary pads.

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## ACRONYMS

IOT: Internet of Things

RFID: Radio Frequency Identification

QR: Quick Response

UPI: Unified Payments Interface

LCD: Liquid Crystal Display

IC: Integrated Circuit

HTML: Hyper Text Markup Language

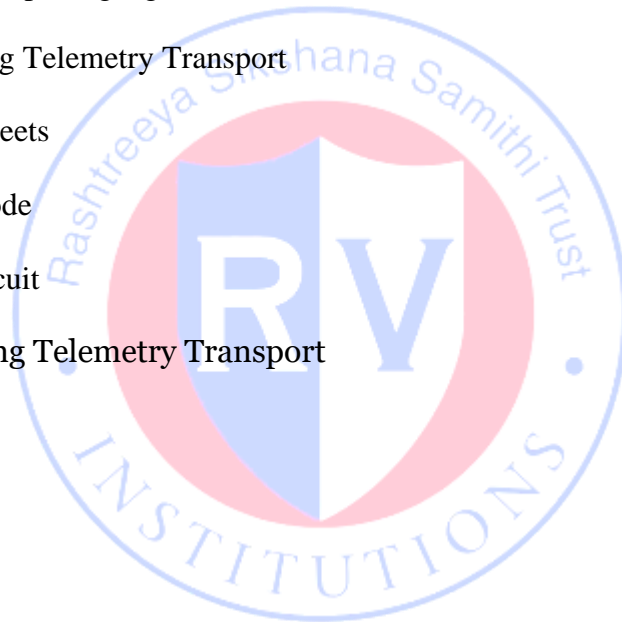
MQTT: Message Queuing Telemetry Transport

CSS: Cascading Style Sheets

LED: Light Emitting Diode

I2C: Inter-Integrated Circuit

MQTT: Message Queuing Telemetry Transport





## Overview

### 1.1 Background

Menstruation is a natural biological process that affects approximately half of the global population, yet it remains a stigmatized and often challenging experience for many women, particularly in underprivileged areas. In many parts of the world, women and girls face difficulties accessing sanitary pads, leading to discomfort, embarrassment, and sometimes even health risks. To address this issue, we have initiated a project to design and implement an IoT-based Sanitary Pad Dispenser that aims to provide a convenient and accessible solution for women during their menstruation period. This dispenser will operate through our custom-made website, allowing users to make online payments for sanitary pads, thereby ensuring a more dignified and accessible menstrual hygiene solution.

### 1.2 The Significance of Menstrual Hygiene

Lack of access to sanitary pads is a critical issue affecting women's health, education, and overall well-being. In many regions, women resort to using unhygienic materials like old rags, leaves, or even newspapers, putting their health at risk. Additionally, the high cost of commercial sanitary pads can be a significant financial burden for families in impoverished communities. The lack of access to proper menstrual hygiene products also contributes to absenteeism in schools and workplaces, limiting women's opportunities for education and economic advancement.

This project aims to leverage the power of the Internet of Things (IoT) to provide an innovative solution to this pressing problem. The IoT-based Sanitary Pad Dispenser will consist of a vending machine-like device that dispenses sanitary pads when a payment is made through our custom-made website. Here's how the project works:

**User Registration:** Users will need to create an account on our website, providing their basic information, contact details, and preferred payment method.

**Online Payment:** To access sanitary pads, users can log in to their accounts and make online payments using various payment methods such as credit/debit cards, mobile wallets, or even government subsidies for those eligible.

**Real-time Inventory Management:** The IoT technology integrated into the dispenser will continuously monitor the stock of sanitary pads. When a user places an order and successfully completes the payment, the dispenser will release the requested number of pads.

**Hygiene and Accessibility:** The dispenser will be designed to ensure hygiene and accessibility. It will be equipped with a user-friendly interface and be built with materials that are easy to clean and maintain.

**Monitoring and Maintenance:** Our team will monitor the dispensers remotely to ensure they are functioning correctly. Regular maintenance and restocking will be carried out to avoid any disruptions in service.

**Accessibility:** This project will make sanitary pads readily accessible to women in urban and rural areas alike, breaking down geographical barriers to menstrual hygiene.

**Affordability:** By allowing users to make online payments, we can offer sanitary pads at competitive prices, ensuring that even low-income individuals can afford them.

**Privacy and Dignity:** The online ordering system and discreet dispensing process respect the privacy and dignity of users, eliminating the embarrassment associated with purchasing sanitary pads in person.

**Health and Hygiene:** Providing access to sanitary pads will promote better menstrual hygiene practices, reducing the risk of infections and other health issues.

**Empowerment:** Access to affordable and hygienic menstrual hygiene products empowers women to participate fully in education, work, and social activities, ultimately contributing to gender equality.

### **1.3 Project Initiation and Objectives**

The IoT-based Sanitary Pad Dispenser project is a step towards addressing the critical issue of menstrual hygiene by providing a convenient, affordable, and dignified solution. By leveraging technology and online payments, we aim to make sanitary pads accessible to women in underserved communities, promoting their health, education, and empowerment. This project embodies the potential of technology to create positive social impact, addressing a fundamental need while contributing to a more equitable society. We look forward to implementing and expanding this project to benefit women across the globe, recognizing that access to menstrual hygiene is a basic human right and a crucial step toward gender equality.

## Empathy

### 2.1 Survey for Female College Students

A meticulously crafted Google form was thoughtfully disseminated throughout our college campus, targeting the female student demographic. The objective was to solicit their invaluable insights and opinions regarding the pressing need for a Sanitary Pad Dispenser within the college premises. This survey yielded an impressive response, with over 80 participants eagerly sharing their perspectives and experiences.

The respondents, hailing from various academic disciplines and walks of life, collectively contributed to the growing chorus advocating for the installation of a Sanitary Pad Dispenser. Their feedback encompassed a wide spectrum of insights, ranging from personal anecdotes to detailed accounts of instances where the absence of such a dispenser had presented notable challenges.

One recurring theme in the responses was the paramount importance of convenience and accessibility. Many respondents recounted occasions when the unavailability of sanitary pads had caused considerable inconvenience. These incidents were not limited to the college campus but extended to various facets of their lives, including classrooms, libraries, and extracurricular activities. In such moments of urgency, the absence of a readily accessible solution was acutely felt, often resulting in discomfort and distress.

Moreover, the feedback emphasized that the absence of a Sanitary Pad Dispenser did not merely pose logistical challenges but also carried significant emotional and psychological implications. The stigma surrounding menstruation persists in various societal contexts, including educational institutions. Female students shared their discomfort and embarrassment when they were compelled to approach fellow students or college staff to seek sanitary pads. In doing so, they exposed themselves to unnecessary scrutiny and judgment, adding an emotional burden to an already challenging situation.

The survey respondents also underscored the financial implications of relying on traditional methods of acquiring sanitary pads. Many students expressed concerns about the high cost of sanitary products available in local stores, which often strained their limited budgets. This

financial aspect of menstrual hygiene was particularly significant for students from economically disadvantaged backgrounds who struggled to allocate their resources effectively.

Furthermore, the survey revealed that the absence of a Sanitary Pad Dispenser in college facilities had repercussions beyond individual discomfort. It had tangible impacts on academic performance and attendance. Female students described instances when they were forced to skip classes or leave campus due to menstrual discomfort, underscoring the link between accessible menstrual hygiene products and educational attainment.

In addition to the tangible challenges posed by the lack of a dispenser, respondents highlighted the broader societal and gender equity implications. They argued that access to sanitary pads is not a mere convenience but a fundamental aspect of gender equality. By addressing this issue, the college could send a powerful message of support for its female students, signalling that their well-being and dignity are valued and prioritized.

The survey responses resonated with a sentiment that transcended personal anecdotes and individual experiences. They underscored a collective desire for change, a recognition that the absence of a Sanitary Pad Dispenser was not just an inconvenience but a systemic issue that warranted attention and action.

## **2.2 Summary of Survey Findings**

To distil the survey responses into a succinct summary, the overwhelming consensus among female college students is that the implementation of a Sanitary Pad Dispenser within the college premises is not only a pragmatic solution to address immediate needs but also a powerful symbolic gesture. It represents a commitment to gender equality, student well-being, and the removal of barriers that hinder academic and personal growth.

The overwhelming consensus among female college students is that the implementation of a Sanitary Pad Dispenser within the college premises is not only a pragmatic solution to address immediate needs but also a powerful symbolic gesture. It represents a commitment to gender equality, student well-being, and the removal of barriers that hinder academic and personal growth.

## 2.3 Insights into a Multifaceted Problem

Response for the question will the students use the sanitary pad dispenser if installed in the

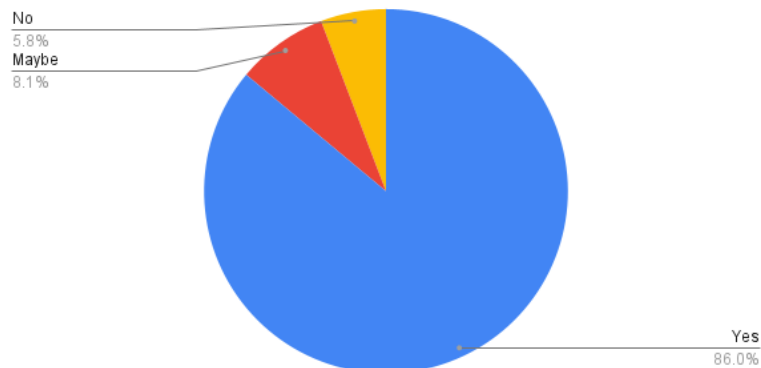


Fig2.1: - Pie chart for the first question

The survey's comprehensive findings reveal a multifaceted problem that extends beyond mere logistics. It highlights the significance of creating an inclusive and supportive environment where female students can thrive without the added burden of inadequate access to menstrual hygiene products. The absence of a Sanitary Pad Dispenser is not just a matter of convenience; it touches upon issues of dignity, financial equity, and gender equality.

The graph of the responses is given below in Figures 2.1 and 2.2 in which the Pie clearly shows that installation of Sanitary Pad Dispenser is very necessary in the premises of college.

Count of How important do you think it is to have pad dispensers in the restrooms at RV College?

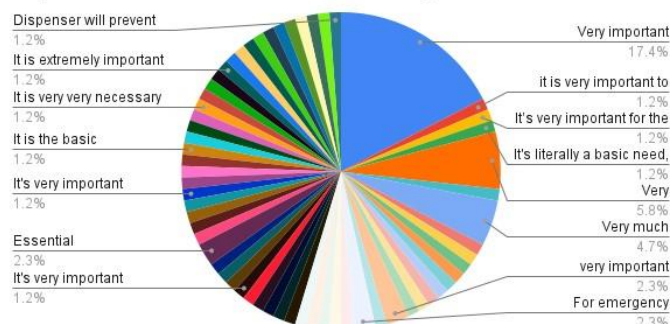


Fig2.2: - Pie chart for the second question

## **Problem Statement**

The absence of a readily accessible Sanitary Pad Dispenser within our college premises presents a pressing issue that demands immediate attention and resolution. This problem statement encapsulates the multifaceted challenges faced by female college students in managing their menstrual hygiene needs, emphasizing both the practical inconveniences and the broader implications for student well-being, dignity, financial equity, and gender equality.

### **3.1 Background**

The lack of a Sanitary Pad Dispenser on campus has led to recurrent instances of inconvenience for female students. The unavailability of menstrual hygiene products within college facilities has forced them to seek alternative solutions, often at a considerable personal cost. Moreover, the traditional methods of acquiring sanitary pads, such as purchasing from local stores, impose financial burdens on students, particularly those from economically disadvantaged backgrounds. This economic strain not only affects individual students but also perpetuates disparities in access to essential menstrual hygiene products.

### **3.2 Academic Impact**

Beyond the practical inconveniences, the absence of a Sanitary Pad Dispenser has tangible academic repercussions. Female students have reported instances where menstrual discomfort and the unavailability of sanitary products have led to class absenteeism or early departures from campus. This highlights the link between accessible menstrual hygiene products and academic performance, with the current situation acting as an impediment to the educational attainment of female students.

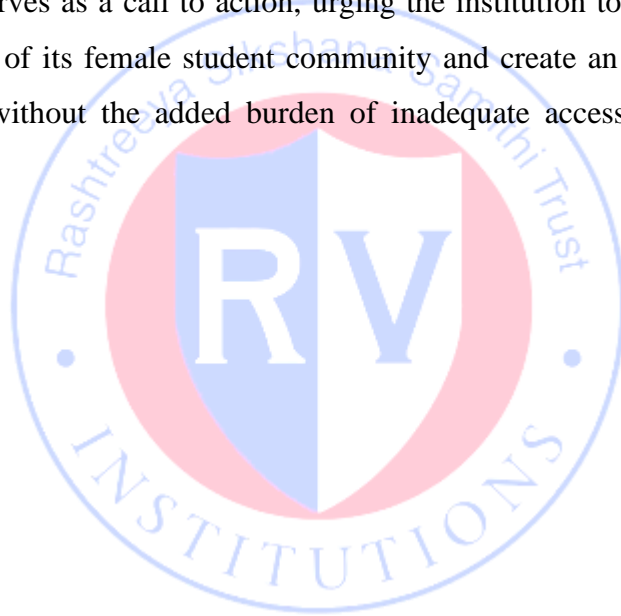
The stigma surrounding menstruation is a pervasive issue, even within educational institutions. Female students have shared their discomfort and embarrassment when compelled to approach fellow students or college staff to request sanitary pads. This exposure to scrutiny and judgment adds an emotional and psychological burden to an already challenging situation, adversely affecting their overall well-being and sense of dignity.

Access to sanitary pads is not merely a matter of convenience but a fundamental aspect of gender equality. The absence of a Sanitary Pad Dispenser perpetuates a gendered disparity, implying that the menstrual hygiene needs of female students are not prioritized or valued. By failing to address this issue, the college misses an opportunity to send a clear message of

inclusivity, support, and commitment to gender equality.

The comprehensive survey responses from female college students echo a collective desire for change. They highlight a systemic issue that transcends individual experiences and anecdotes, emphasizing the need for a Sanitary Pad Dispenser as both a practical solution and a symbolic gesture. The absence of this essential amenity is not only a logistical challenge but also a matter of dignity, equity, and inclusion.

In light of the multifaceted challenges and implications outlined in this problem statement, it is imperative for the college to address the pressing need for a Sanitary Pad Dispenser within its premises. By doing so, the college can demonstrate its commitment to student well-being, gender equality, and inclusivity, setting a precedent for educational institutions to follow. The problem statement serves as a call to action, urging the institution to proactively respond to the needs and voices of its female student community and create an environment where all students can thrive without the added burden of inadequate access to menstrual hygiene products.





## **Ideate**

In the pursuit of designing a technologically advanced and user-friendly sanitary pad dispenser solution, a comprehensive exploration of various IoT-based dispenser types was undertaken. The primary objective was to discern the most suitable and efficient implementation method. The types of dispensers subjected to research and evaluation encompassed manual operation, token-based dispensers, RFID-based dispensers, and QR-based dispensers.

### **4.1 Exploration of Sanitary Pad Dispenser Types**

#### **4.1.1 Token-Based Sanitary Pad Dispenser**

Token-based sanitary pad dispensers operate on the fundamental principle of circuit completion. This method hinges on user initiation, involving the insertion of a coin into the vending machine. Upon coin detection, the machine employs techniques such as image processing to identify the coin, subsequently facilitating the dispensation of the selected pads. The user is afforded the autonomy to specify the pad's size and quantity according to personal preferences.



Fig 4.1 A Token Based Sanitary Pad

#### **4.1.2 RFID-Based Sanitary Pad Dispenser**

RFID-based sanitary pad dispensers are characterized by the issuance of unique RFID cards or tags to students. These RFID tags are designed to be compatible with RFID readers that are securely mounted on the dispensing machines. Each student is assigned a distinctive identification (ID) linked to their RFID card. The associated cost of the dispensed sanitary



pads can either be tracked and billed accordingly or managed through a recharge system, offering a tailored and controlled access experience.



Fig 4.2 RFID based Sanitary Pad Dispenser

#### 4.1.3 QR-Based Sanitary Pad Dispenser

QR-based sanitary pad dispensers utilize the ubiquitous QR code technology. These machines are equipped with QR codes either physically affixed to the dispenser unit or integrated into a dedicated mobile application. Students leverage this technology to make selections regarding pad size and quantity via the mobile app, finalizing the payment using Unified Payments Interface (UPI) methods.



Fig 4.3 QR Based Sanitary Pad Dispenser

## 4.2 Cost Analysis of Different Dispenser Types

In order to make a judicious choice regarding the most pragmatic implementation method, an exhaustive cost analysis was conducted across distinct dispenser categories. The analysis encompassed an evaluation of each category's features and associated costs:

This category boasts a storage capacity of up to 50 napkins, enabling cash payments. It operates autonomously, and the cost of acquisition is estimated at ₹6,000.

Offering similar storage capacity to its coin-based counterpart, this machine also accepts cash payments and operates automatically. However, the cost of this system is relatively higher, amounting to ₹16,000. With a storage capacity of 30 napkins, this dispenser distinguishes itself by supporting UPI payments. Like the others, it functions automatically and comes at a cost of ₹23,000.

## 4.3 Proposed Solution: App-Based Sanitary Pad Dispenser

Subsequent to comprehensive research and meticulous analysis, the decision was made to implement an app-based sanitary pad dispenser solution. This selection is grounded in the overarching objective of providing an encompassing and accessible solution for college students, while simultaneously ensuring seamless usability and convenience.

### 4.3.1 Key Features of the Proposed App-Based Dispenser

The proposed app-based dispenser boasts several key features:

**Size and Quantity Selection:** Users are afforded the liberty to select the desired size and quantity of sanitary pads through the dedicated mobile application, enabling a highly personalized experience.

**Secure UPI Payment Integration:** The dispenser seamlessly integrates with the Razor pay payment gateway, ensuring secure and user-friendly UPI-based payments.

**Servo Motor for Dispensing:** To guarantee precise and efficient dispensation, the system employs a servo motor, enabling the accurate delivery of the selected quantity and size of sanitary pads.

**Comprehensive Access:** The app-based solution is thoughtfully designed to provide access to a diverse range of sanitary pad sizes, catering to the distinct requirements of the college student community.

## 4.4 Benefits and Implications of the Proposed Solution

The selection of an app-based sanitary pad dispenser is anticipated to yield numerous benefits and far-reaching implications:

**Enhanced Accessibility:** The solution significantly enhances accessibility, ensuring that students can conveniently access a variety of sanitary pad sizes, ultimately promoting comfort during menstruation.

**Gender Equality:** By proactively addressing the menstrual hygiene needs of female students, the college demonstrates an unwavering commitment to gender equality and inclusivity.

**Financial Equity:** The incorporation of UPI-based payments ensures that students from diverse financial backgrounds can access sanitary pads without incurring undue financial strain, particularly benefiting those from economically disadvantaged segments.

**Reduced Absenteeism:** The enhanced access to sanitary pads is projected to reduce instances of class absenteeism and early departures, ultimately contributing to improved academic performance.

**Privacy and Dignity:** The app-based solution is designed to safeguard user privacy and dignity. It eliminates the potential discomfort associated with seeking assistance from peers or college staff.

The ideation and research findings presented in this chapter culminated in the informed decision to implement an app-based sanitary pad dispenser solution. This selection aligns harmoniously with the overarching mission to provide comprehensive and convenient access to menstrual hygiene products for college students. By adopting this approach, the institution aims to cultivate a campus environment that places a premium on the well-being, dignity, and gender equality of every student, thereby contributing to the realization of a more inclusive and supportive educational institution.

## Prototype

### 5.1: Hardware Model of the Prototype

The IoT-based Sanitary Pad Dispenser comprises several essential components: the ESP32 microcontroller, serving as the central control unit, orchestrating the device's operation; a Servo MG996R Motor, responsible for precision pad dispensing; an LCD display with I2C IC, offering a user-friendly interface to monitor remaining pad availability; a Buzzer to audibly indicate successful pad dispensation, enhancing user experience; and LED lights, serving as visual indicators to convey operational status. Together, these components work harmoniously to create an efficient and user-centric solution for addressing the accessibility and availability of sanitary pads during menstruation.

#### 5.1.1 Microcontroller - ESP32

The central component driving the IoT-based sanitary pad dispenser is the ESP32 microcontroller, a judicious choice considering both functionality and cost-effectiveness. The ESP32 provides a compelling balance of computational power and affordability, aligning seamlessly with budgetary constraints. Its integrated Wi-Fi and Bluetooth capabilities eliminate the need for separate communication modules, thus reducing component costs and system complexity. Further enhancing cost-effectiveness, the ESP32 exhibits low power consumption, extending operational uptime and promoting long-term cost savings in energy usage. The ESP32 enjoys strong community support and an open-source development environment, streamlining project development through readily available libraries and resources. Its Over-the-Air (OTA) update capabilities facilitate remote software updates, reducing maintenance costs by eliminating the need for physical device access. The ESP32's modular architecture enables future feature additions without significant hardware changes, reinforcing long-term cost-effectiveness.



**Fig 5.1** Esp 32 used in the mechanism

### 5.1.2 Dispensing Mechanism - Servo MG996R Motor

The Servo MG996R Motor serves as the core of the sanitary pad dispensing mechanism, characterized by precision and cost-effectiveness. Its precision control ensures accurate and repeatable pad dispensing, minimizing wastage and optimizing resource utilization. Durability is a key attribute, significantly reducing the need for frequent replacements or maintenance, which can incur costs over time. The motor's wide operating voltage range enhances versatility without compromising cost-effectiveness. Its straightforward control interface through PWM signals simplifies integration into the project, reducing development complexity. Additionally, its low noise operation is beneficial in environments where noise control measures could entail added costs.



**Fig 5.2** The usage of Servo Mechanism

### 5.1.3 Display Unit - LCD Display with I2C IC

The LCD display integrated into the dispenser utilizes an I2C IC, a prudent choice for efficiency and cost-effectiveness. I2C communication streamlines interactions with the display, simplifying the wiring infrastructure and reducing material costs. These displays boast energy efficiency, aligning well with energy-saving goals and contributing to long-term operational cost savings. High visibility and clarity further mitigate the potential for user errors that could incur additional costs. The compact form factor of these displays contributes



to efficient space utilization, potentially reducing the size and cost of enclosures or housings. Moreover, compatibility with standard libraries expedites development, reducing costs associated with custom display drivers. Their reliability minimizes the risk of display failures and associated repair or replacement costs.



**Fig 5.3 LCD Display**

#### **5.1.4 Control Unit - PCA9685 Shield**

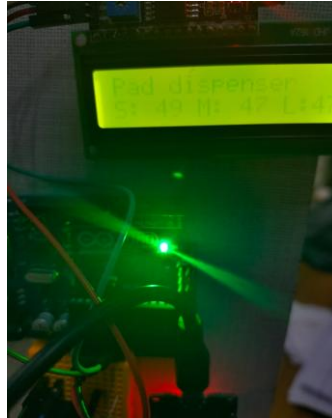
The PCA9685 Shield plays a crucial role in controlling various dispenser components, offering precise PWM control with cost-effectiveness in mind. It efficiently manages multiple servos, LEDs, and other devices without incurring excessive costs. The PCA9685's 16 PWM channels reduce the need for additional controllers, further optimizing cost-efficiency. Its I2C interface simplifies integration into the project, streamlining wiring complexity and material costs. Energy efficiency is a notable feature, contributing to long-term cost-effectiveness by minimizing power consumption during PWM signal generation. Customizable PWM frequencies enhance control flexibility, reducing potential compatibility issues and their associated costs. Compact form factor eases integration, potentially reducing the size and cost of enclosures or housings while maximizing space utilization.

#### **5.1.5 Multiplexing Unit - TCA9546A 4-Channel I2C Bus Multiplexer**

The TCA9546A 4-Channel I2C Bus Multiplexer offers an economical solution for expanding the I2C bus capabilities of the dispenser. It allows multiple I2C devices to share a single microcontroller, effectively reducing the need for additional microcontrollers and their associated costs. The four channels provided by the TCA9546A facilitate the connection of multiple I2C devices, further streamlining costs by consolidating communication pathways. Compatibility with the I2C protocol simplifies integration into the project, reducing wiring complexity and material costs. Low power consumption during I2C signal routing aligns with energy-saving goals and overall cost-effectiveness. Customizable channel selection ensures precise communication with specific I2C devices, minimizing the potential for bus conflicts and errors. Its compact form factor promotes efficient integration, potentially reducing enclosure or housing size and cost while optimizing space utilization.

### 5.1.6 Visual Indicators - LED Lights

The inclusion of LED lights as visual indicators within the dispenser reflects a cost-effective approach to providing status feedback. LEDs serve as efficient visual indicators, offering clear status feedback



**Fig 5.4:** With LED's

to users without incurring additional component expenses. Their energy-efficient operation aligns with cost-saving objectives, consuming minimal power and contributing to long-term operational cost savings. The long operational lifespan of LEDs reduces the need for frequent replacements and associated costs. LEDs are available in various colors, allowing for flexible visual cues without incurring additional cost or complexity. Their instant illumination provides immediate feedback to users, potentially preventing errors and the associated costs they may incur. Compact and space-efficient, LEDs' small form factor reduces space requirements, potentially lowering the cost of enclosures or housings while ensuring efficient use of available space. The Led will glow indicating that the information from the server is received to the microcontroller and the process for dispensing is initiated.

### 5.1.7 Sanitary Pad Stacking Mechanism

The Sanitary Pad Stacking Mechanism is a cornerstone of the IoT-based sanitary pad dispenser, characterized by its innovative design and cost-effectiveness. This mechanism has been meticulously engineered to offer several key advantages:

**Stacking Efficiency:** The primary function of this mechanism is to systematically stack sanitary pads on top of each other with precision and reliability. It ensures that the available space within the dispenser is optimally utilized, allowing for the storage and easy retrieval of a significant quantity of sanitary pads. By stacking pads efficiently, the mechanism minimizes the need for constant refilling, translating into considerable long-term cost

savings.

**Space-Saving Design:** The mechanism's ingenious design enables the vertical stacking of up to 100 sanitary pads within a compact area. This space-saving feature is invaluable, especially in settings where available space is at a premium. The reduction in the frequency of restocking is not only convenient but also cost-effective, as it lessens the labour and time required for maintenance.

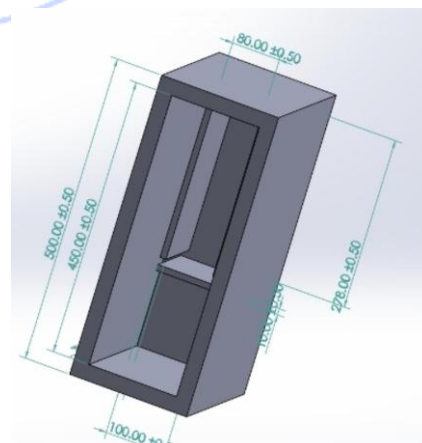
**Minimized Wastage:** The mechanism's precise operation ensures that only one sanitary pad is dispensed at a time, eliminating the risk of multiple pads being released accidentally. This feature not only enhances user experience by preventing inconvenience but also minimizes wastage. In environments where every pad is valuable, such as educational institutions or community centres, this aspect of the mechanism translates into tangible cost savings over time.

**Easy Refilling:** Keeping maintenance and downtime to a minimum is crucial in any dispenser. The stacking design of this mechanism facilitates straightforward pad replenishment. When it's time to restock, the process is efficient and user-friendly, minimizing downtime and avoiding disruptions in service. Reduced maintenance requirements translate to lower labour costs and operational efficiency.

**Cost-Effective Storage:** The mechanism's ability to stack a significant number of pads in a single location is a cost-saving feature that should not be overlooked. By reducing the need for frequent restocking, it minimizes the labour and materials required for maintenance. Over time, these savings accumulate, making this mechanism an economically sound choice.



**Fig 5.5**



**Fig 5.6**

**Fig 5.5 Sanitary Pad Stacking Mechanism**

**Fig 5.6 The CAD model of the mechanism developed in SolidWorks**



## 5.2: Software Model of the Prototype

### 5.2.1 Development of the Web-Based System

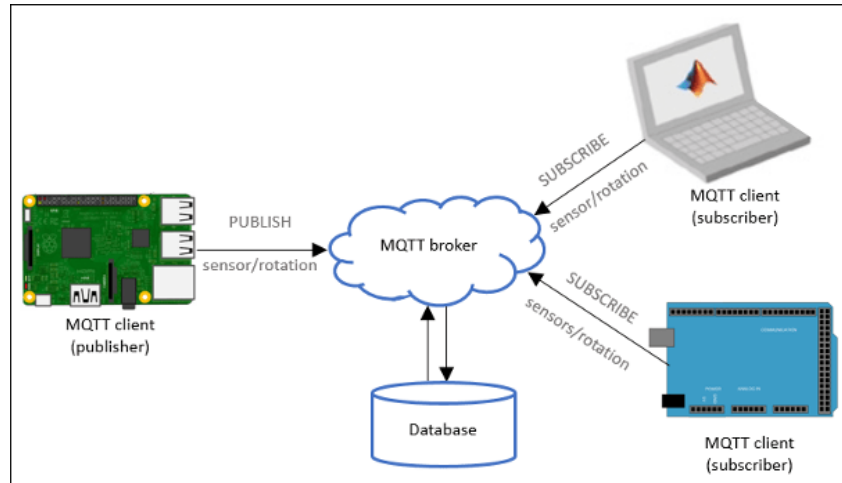


**Fig 5.7** Node.js Architecture used for Backend development.

The development of a web-based system to facilitate sanitary pad dispensing represents a significant milestone in our project. This system was meticulously designed to address the pressing need for an efficient and accessible solution. Leveraging a comprehensive technology stack, our team harnessed Node.js to power the backend logic, while HTML and CSS formed the foundation of the frontend design. To ensure a seamless user experience, we employed Embedded C for microcontroller integration. This multifaceted approach allowed us to create a cohesive platform that seamlessly connects vendors with the ESP32 microcontroller, enabling efficient order processing and pad dispensing.

#### 5.2.2 Robust Communication Channels

One of the critical aspects of our software model was the establishment of robust communication channels between the vendor site and the ESP32 microcontroller. We achieved this by implementing the MQTT (Message Queuing Telemetry Transport) protocol. MQTT's lightweight nature and efficiency make it an ideal choice for IoT applications like sanitary pad dispensing. It allows for the seamless transmission of messages while minimizing data overhead. This protocol guarantees reliable message delivery, ensuring that orders are processed accurately and in a timely fashion. Moreover, MQTT's support for Quality of Service (QoS) levels provides the flexibility to balance efficiency and reliability, adapting to the specific needs of our system. As the project evolves, MQTT's scalability ensures that multiple devices can connect and communicate seamlessly, accommodating future growth and expansion.



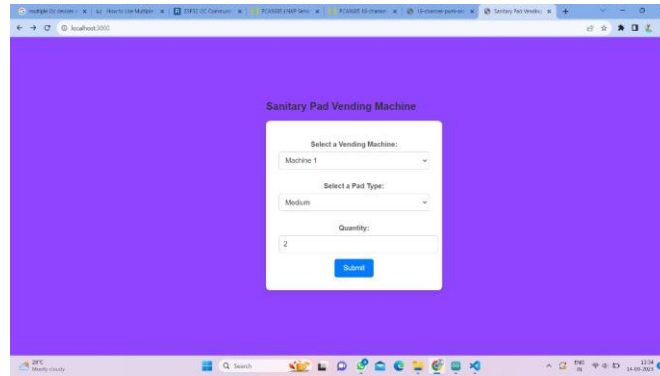
**Fig 5.8** Illustration of MQTT protocol working

### 5.2.3 Intelligent Order Processing and Pad Dispensing Logic

Our software model incorporates an intelligent order processing and pad dispensing logic. This logic optimizes resource usage and minimizes wastage, aligning with our project's cost-effectiveness objectives. Node.js, as the backbone of our backend operations, plays a pivotal role in handling incoming MQTT messages, processing orders, and managing communication between the vendor site and the ESP32. This real-time communication ensures that vendors receive timely updates on order status while maintaining system responsiveness, even during concurrent connections from multiple vendors. Node.js's adaptability to dynamic adjustments, such as order prioritization and real-time stock updates, enhances the efficiency of our system. Its scalability allows us to accommodate increasing order traffic, ensuring a reliable service as demand continues to grow.

### 5.2.4 User-Friendly Interface Design

In our frontend development, HTML and CSS work in tandem to create a user-friendly interface for vendors. HTML forms the site's structural foundation, defining content and interactivity, while CSS enhances the visual presentation, ensuring an engaging user experience. Responsiveness is a core focus, allowing the site to seamlessly adapt to various screen sizes, including mobile devices and desktops. The frontend customization, facilitated by HTML and CSS, streamlines the order submission process, making it intuitive and efficient. CSS further contributes to layout design, color schemes, typography, and animations, resulting in a consistent and visually appealing design language. The primary goal is to deliver a user-friendly experience, simplifying navigation and optimizing input forms for smoother interaction. By harmonizing HTML's structural elements with CSS's aesthetics, our frontend creates a compelling and approachable interface for vendors.



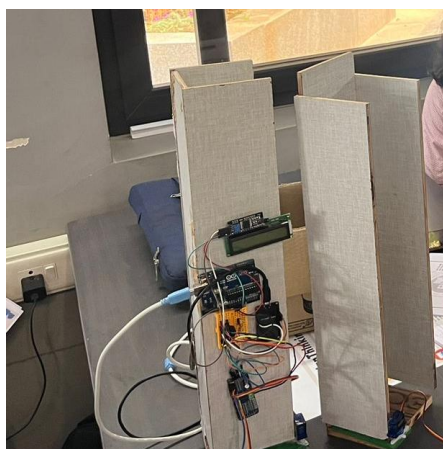
**Fig 5.9** Website User Interface

### 5.3 Testing

The successful testing phase signifies significant progress toward the implementation and deployment of the IoT-based Sanitary Pad Dispenser. This project holds the potential to significantly impact women's lives by addressing a critical societal issue while upholding principles of dignity and gender equality. The complete implementation of all the hardware and software components of the module is shown on Fig 5.10.

During the testing phase of the IoT-based Sanitary Pad Dispenser project, an extensive evaluation of the dispenser mechanism was conducted to ascertain its reliability, precision, and consistency. The primary objective was to ensure the dispenser's capability to efficiently fulfil orders placed through the custom-made website, precisely dispensing the correct quantity and size of sanitary pads.

The testing methodology comprised a series of real-world usage scenarios aimed at assessing the dispenser's performance under varying conditions. The dispenser was subjected to diverse order requests, including different quantities and sizes of sanitary pads, to evaluate its functionality comprehensively.



**Fig 5.10** Testing Model

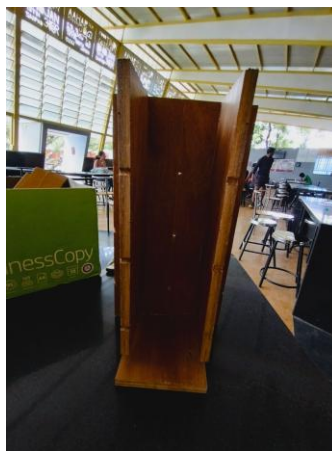
The results obtained during the testing phase were highly promising. The dispenser mechanism consistently exhibited exceptional precision and reliability in dispensing sanitary pads. It reliably and accurately fulfilled orders, underscoring its suitability for practical application.

Some of the factors considered for the creating of this mechanism are: -

- **Ease of Maintenance:** The dispenser mechanism is built with durability and longevity in mind. Its robust construction and thoughtful design make maintenance straightforward and hassle-free. This translates to reduced downtime and the need for infrequent repairs, resulting in significant cost savings over the long term. Maintenance teams can easily access and service the mechanism, ensuring uninterrupted functionality.
- **User-Friendly Interface:** User experience is at the forefront of the dispenser's design, and this is reflected in its intuitively designed interface. The user-friendly nature of the dispenser ensures that individuals can interact with the device effortlessly. Whether it's ordering sanitary pads or simply navigating the system, the interface enhances the overall user experience, promoting convenience and accessibility.

The testing phase encompassed an evaluation of various communication protocols employed to connect the custom-made website with the ESP8266 microcontroller integrated into the dispenser. The protocols assessed included HTTP, WebSocket, and MQTT, with a focus on data transmission speed, reliability, and efficiency.

MQTT emerged as the preferred communication protocol among those tested due to its robustness and efficiency.



**Figure 5.11** The various mechanisms used during testing

Some of the advantages of Communication MQTT over the other communication protocol which makes it optimum for this project is that

- **Reliability:** MQTT stands out in its exceptional reliability, particularly in challenging network conditions. This level of dependability is crucial for functions like order processing and real-time status updates, where the accuracy of information is paramount. Users can trust that their orders will be processed and updated accurately, instilling confidence in the system.
- **Real-time Updates:** One of MQTT's most significant advantages is its support for real-time communication. This capability enables instantaneous updates on order status and inventory levels. Users receive timely information, enhancing their overall experience by ensuring they remain informed about the availability of sanitary pads. This real-time feature aligns seamlessly with the project's objectives of providing convenience and accessibility.
- **Efficiency:** MQTT's efficiency in data transmission is a standout feature, significantly reducing the burden on network resources. This efficiency leads to reduced data overhead, resulting in improved overall system performance. By minimizing the demands on network resources, MQTT ensures that the IoT-based Sanitary Pad Dispenser operates smoothly and efficiently, even in resource-constrained environments.
- **Scalability:** MQTT's inherent scalability is a valuable asset, allowing for the seamless addition of multiple devices and users without compromising performance. As the project expands to accommodate more dispenser units and users, MQTT effortlessly supports the system's growth. This scalability feature ensures the long-term viability and sustainability of the dispenser system, making it an ideal choice for the project's objectives.

Rigorous functionality testing was conducted on the custom-made website, a pivotal project component. Test scenarios encompassed all website operations, including user registration, online payment processing, order placement, and user account management. The objective was to validate the seamless and intended operation of all website functions.

The results of website functionality testing were overwhelmingly positive, with users able to effortlessly create accounts, make online payments, place orders, and manage their accounts without encountering significant issues.

## 5.4 Applications

The IoT-based Sanitary Pad Dispenser project is a testament to the transformative power of innovation and technology. While initially conceived to address menstrual hygiene challenges, this versatile system has proven its potential to transcend its original purpose and find relevance in diverse settings. Its adaptability, precision, and real-time capabilities make it a powerful solution that can enhance accessibility and convenience across various domains.

In the healthcare sector, the IoT-based dispenser can revolutionize patient care. Patients with chronic illnesses or those requiring regular medication can benefit immensely from a smart dispenser. Beyond providing the prescribed dosages at scheduled times, this system can send real-time notifications and updates to healthcare providers and family members. This not only promotes medication adherence but also ensures that patients receive timely and accurate doses, improving overall healthcare outcomes.

In educational institutions, the dispenser's design and user-friendly interface can be leveraged for broader applications. It can serve as a multifunctional vending machine, offering school supplies, stationery, or even snacks to students. This streamlined access to essential items fosters a more efficient and organized learning environment, enhancing the overall educational experience.

Moreover, the dispenser's online payment system can be adapted for a variety of vending scenarios, such as in public transportation for ticketing or at retail stores for self-checkout processes. By facilitating cashless transactions, this feature not only streamlines the payment process but also contributes to enhanced security and operational efficiency.

The adaptability of the IoT-based Sanitary Pad Dispenser highlights the boundless potential of technology to address multifaceted challenges and create solutions that benefit a wide range of users and industries. As the project continues to evolve, further exploration of these wider applications and adaptation to diverse contexts could unlock new opportunities for improving lives and enhancing user experiences across various domains.



## Conclusion and Future Scope

In this comprehensive exploration of the IoT-based Sanitary Pad Dispenser project, we have delved into its various facets, from the identification of the problem to the development of the hardware and software components. This initiative seeks to address a critical issue: the accessibility and availability of sanitary pads for women during menstruation. Through meticulous research, ideation, and implementation, the project endeavours to provide a cost-effective, user-friendly, and efficient solution.

The project's hardware model showcases the integration of key components, such as the ESP32 microcontroller, the Servo MG996R Motor, LCD display with I2C IC, Buzzer, and LED Lights. Each component serves a unique role, contributing to the dispenser's functionality and user experience. Notably, the Sanitary Pad Stacking Mechanism stands as a testament to innovation and cost-effectiveness, efficiently organizing and dispensing pads while minimizing wastage and maintenance costs.

On the software front, the project has developed a web-based system that seamlessly connects vendors with the ESP32 microcontroller. Node.js, HTML, and CSS form the backbone of the system, enabling intelligent order processing, efficient communication, and a user-friendly interface. The integration of the MQTT protocol ensures reliable and efficient communication between the vendor site and the microcontroller, facilitating real-time updates and precise order fulfilment.

As we look toward the future, there are several avenues for further development and expansion of the IoT-based Sanitary Pad Dispenser project. These possibilities extend beyond the initial implementation and highlight the project's potential for broader impact:

Scalability is a critical consideration for the future of the IoT-based Sanitary Pad Dispenser project. As demand for these dispensers increases, the project can be expanded to cater to a larger user base. This includes deploying dispensers in a variety of settings, such as schools, colleges, public restrooms, and community centres. By designing the system to accommodate additional units seamlessly, the project can ensure that more individuals have access to sanitary pads when needed. Implementing a centralized management system that can monitor and control multiple dispensers from a single location can further enhance scalability.

Customization is another avenue for future development. Different users may have distinct preferences when it comes to sanitary pad sizes, brands, or materials. To address this, the project can explore options for allowing users to select specific types of sanitary pads through the dispenser interface. Additionally, the dispenser can be designed to handle a variety of pad

sizes to cater to diverse user needs. This customization not only enhances user satisfaction but also ensures that the project can adapt to a wide range of sanitary pad products.

Integrating data analytics capabilities into the project opens up possibilities for informed decision-making. By collecting data on dispenser usage, stock levels, and user behavior, the project can gain insights into patterns and trends. For instance, it can predict when stock needs replenishment or when maintenance is required. This data-driven approach optimizes resource management, reduces operational costs, and ensures that sanitary pads are consistently available. Furthermore, data analytics can support evidence-based policy decisions and advocacy efforts by providing concrete data on the project's impact and the broader issue of menstrual hygiene.

Sustainability is an essential consideration for the project's future. Exploring eco-friendly materials for dispenser construction and incorporating energy-efficient components can reduce its environmental footprint. For instance, integrating solar panels or energy-efficient sensors can power the dispenser, reducing electricity consumption. The project can also explore sustainable sourcing of sanitary pads to ensure that the entire supply chain is environmentally responsible. By adopting green technologies and sustainable practices, the project aligns with global sustainability goals while also reducing long-term operational costs.

Developing a dedicated mobile application for the project offers significant potential. The app can serve as an additional interface for users to interact with the dispenser. Users could check real-time stock levels, place orders remotely, and receive notifications about order status through the app. This mobile solution enhances accessibility and user engagement, particularly for individuals who rely heavily on smartphones. It also provides a convenient way for users to find nearby dispensers, further expanding the project's reach. The mobile app can also support features like user feedback and reviews, fostering a sense of community and trust among users.

Inclusivity is paramount for the project's future. Incorporating accessibility features can ensure that the dispenser is usable by individuals with disabilities. For instance, voice command functionality can allow visually impaired users to interact with the dispenser. Braille instructions can be added to the user interface for those who are blind or visually impaired. Tactile cues and audible feedback can guide users through the dispensing process, making the project accessible to a broader range of users. Prioritizing accessibility ensures that no one is left behind in the quest for menstrual hygiene.

Engaging with local communities and partnering with organizations can amplify the project's



impact. Outreach programs can educate communities about the importance of menstrual hygiene and the availability of these dispensers. Collaborations with non-governmental organizations (NGOs) can facilitate distribution to underserved regions, ensuring that the project reaches those in need. Additionally, community engagement can involve training local individuals to maintain and operate the dispensers, fostering sustainability and local ownership. By actively involving the communities it serves, the project can build trust and establish itself as a valuable resource.

The project's impact can extend beyond local boundaries. Global expansion involves taking the lessons learned from initial deployments and replicating the project in regions with limited access to menstrual hygiene products. This expansion aligns with broader international efforts to address menstrual hygiene challenges. Partnerships with international organizations, such as UNICEF or UN Women, can provide the project with the resources and support needed to reach a global audience. By expanding its reach to regions where menstrual hygiene is a significant issue, the project can contribute to a larger movement dedicated to improving women's health and well-being worldwide.

The future scope of the IoT-based Sanitary Pad Dispenser project is filled with opportunities for growth, innovation, and impact. By addressing scalability, customization, data analytics, sustainability, accessibility, community engagement, and global expansion, the project can continue to make a meaningful difference in the lives of women and girls, ensuring their access to essential menstrual hygiene products while also contributing to broader societal goals.

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