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UPI-BASED SMART SANITARY NAPKIN VENDING MACHINE

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ABSTRACT

Menstrual hygiene remains a pressing concern, particularly in regions where access to sanitary products is limited by affordability, availability, and social stigma. This paper introduces a UPI-based smart sanitary napkin vending machine designed to provide a secure, cashless, and user-friendly solution for product distribution. By integrating India's Unified Payments Interface (UPI), the system enables instant digital transactions through QR code scanning, eliminating the need for physical currency and simplifying access.

The vending machine employs a microcontroller-driven dispensing mechanism, supported by sensors to monitor stock levels and operational status. Its IoT-enabled design ensures reliability, predictive maintenance, and scalability for deployment in schools, workplaces, and public facilities. Beyond technical efficiency, the system addresses cultural sensitivities by automating distribution, thereby reducing human interaction.

Pilot testing demonstrates efficient dispensing, secure payment processing, and positive user feedback. The proposed solution offers a sustainable, scalable, and socially impactful approach to menstrual hygiene management.

INTRODUCTION

Menstrual hygiene is an essential aspect of women's health, yet access to sanitary products remains a challenge in many parts of the world. Social stigma, lack of awareness, and limited distribution infrastructure often prevent women from obtaining affordable and hygienic menstrual products. In India, despite growing awareness campaigns, the availability of sanitary napkins in schools, colleges, workplaces, and public spaces is still inadequate. Addressing this issue requires innovative solutions that combine technology, affordability, and accessibility.

This paper introduces a UPI-based smart sanitary napkin vending machine designed to provide a secure, cashless, and user-friendly method of product distribution. Unified Payments Interface (UPI), a widely adopted digital payment system in India, enables instant transactions through mobile applications and QR code scanning. Integrating UPI into vending machines eliminates the need for physical currency, reduces operational complexity, and ensures inclusivity across diverse user groups. The proposed system leverages microcontroller-based hardware and IoT-enabled sensors to automate dispensing, monitor stock levels, and support predictive maintenance. Beyond technical efficiency, the vending machine addresses cultural sensitivities by minimizing human interaction, thereby reducing discomfort associated with menstrual product purchase.

This innovation aligns with national initiatives on digital inclusion and women's empowerment, offering a scalable and sustainable approach to menstrual hygiene management.

Research Paper

OBJECTIVES

The primary objective of this research design Implement a UPI-based smart sanitary napkin vending machine that ensures affordable, accessible, and hygienic menstrual product distribution through secure digital transactions. The system aims to eliminate the dependency on physical currency by integrating India's Unified Payments Interface (UPI), thereby simplifying the purchasing process and promoting cashless convenience.

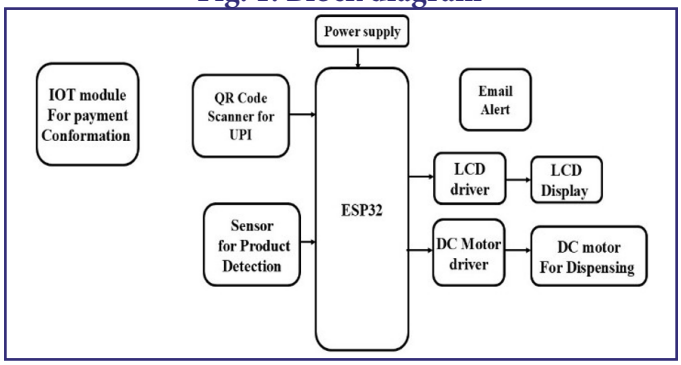
Key objectives include:

- Developingareliabledispensingmechanism controlled bya microcontroller to ensureaccurate and efficient delivery ofsanitary napkins.
- IntegratingUPIpaymentfunctionalitythroughQR code scanning and mobile applicationsto enable instant, secure, anduser-friendly transactions.
- IncorporatingIoT-enabledsensorsformonitoring stock levels, machinehealth, and predictive maintenance, ensuringuninterruptedservice.
- Designingacost-effectiveandscalablesolution suitablefor deployment in schools,colleges, workplaces, and publicfacilities.
- Promotingmenstrualhygieneawarenessbyreducing social stigma throughautomated, contactlessdistributionthatminimizeshumaninteraction.
- Facilitatingdatacollectionandanalysisofusage patterns tosupportpolicymakers, NGOs, and healthcareinitiativesinimprovingmenstrual health management.

Byachieving theseobjectives,the proposed systemseeksto deliver a sustainable,socially impactful, and technologically advanced solution that aligns withnational goalsof digital inclusion and wom en' sem powerm ent.

METHODOLOGY

Fig. 1: Block diagram



The proposed UPI-based smart sanitary napkin vending machine is developed through a systematic approach that integrates hardware, software, and payment technologies to ensure efficient and user-friendly operation.

The hardware design centers on a micro controller unit (MCU) that controls the dispensing mechanism. A motor-driven system is employed to release sanitary napkins upon successful payment confirmation. Sensors are integrated to monitor stock levels, detect mechanical faults, and provide real-time feedback to the controller. This ensures reliability and minimizes downtime.

On the software side, the vending machine incorporates IoT-enabled modules for communication and monitoring. The system is programmed to interface with the UPI payment gateway, allowing users to complete transactions via QR code scanning or mobile applications. Once payment is verified, the MCU triggers the dispensing mechanism. The software also logs transaction details and usage statistics, which can be analyzed for demand forecasting and policy planning.

The payment integration leverages India's Unified Payments Interface (UPI), ensuring secure, instant, and cashless transactions. QR codes are displayed on the machine, and users can scan the musing any UPI-enabled mobile application. This eliminates the need for physical currency and enhances accessibility.

To validate the system, pilot testing was conducted in controlled environments such as educational institutions and workplaces. Performance metrics include transaction success rate, dispensing accuracy, and user satisfaction. Data collected during trials was used to refine the design, improve reliability, and ensure scalability.

This methodology ensures that the vending machine is cost-effective, socially impactful, and technologically robust, aligning with digital inclusion and women's health initiatives.

APPLICATIONS

The UPI-based smart sanitary napkin vending machine has diverse applications aimed at improving menstrual hygiene accessibility and promoting digital inclusion. Its deployment Can be particularly impactful in educational institutions such As schools and colleges, where young women often face challenges in obtaining sanitary products discreetly. By providing automated, cashless access, the system encourages regular usage and reduces absenteeism linked to menstrual discomfort. In workplaces and corporate environments, the vending machine supports employee well-being by ensuring hygienic products are readily available, thereby fostering inclusive and supportive work cultures. Similarly, installation in public facilities such as bus stations, railway stations, airports, and shopping complexes enhances accessibility for women on the move, offering convenience and dignity. Healthcare centers and community clinics can also benefit From the system, as it provides a reliable distribution channel for menstrual products while simultaneously collecting usage data that can inform public health initiatives. Furthermore, the Machine can be integrated into government and NGO-ledprograms focused on women's health, serving as a scalable solution for rural and urban outreach.Overall, the vending machine's applications extend beyond product distribution to include awareness creation policy support, and social empowerment, making a versatile tool for advancing menstrual hygiene management.

PROJECT SETUP FUTURE SCOPE

The UPI-based smart sanitary napkin vending machine presents significant opportunities for future enhancement and scalability. One promising direction is the integration of AI-driven analytics to study usage patterns, predict demand, and optimize stock replenishment. This would allow institutions and policymakers to make data-informed decisions on menstrual health initiatives.

Another scope lies in expanding multi-language support and voice-assisted interfaces, ensuring inclusivity for users across diverse literacy levels and regions. Incorporating biometric authentication could further enhance security, particularly in Sensitive environments like schools and workplaces.

The system can also evolve into a multi-product vending solution, offering a range of hygiene products such as tampons, pantyliners, and menstrual cups, thereby broadening its impact. Integration with government health schemes and NGO programs could enable subsidized or free distribution in rural and underserved areas.

From technological perspective, future versions may adopt solar-power modules for energy efficiency, making the machines sustainable in off-grid locations. Additionally, linking the system with cloud-based dashboards would allow centralized monitoring of multiple machines, ensuring seamless management at scale.

CONCLUSION

The development of a UPI-based smart sanitary napkin vending machine offers apractical, scalable, and socially impactful solution to menstrual hygienechallenges. Byintegrating India' sUnified Payments Interface(UPI),the systemensuressecure, cashlesstransactions, eliminatingtheneedfor physical currency and simplifying access for users. The microcontroller-drivendispensingmechanism,supportedby IoT-enabledsensors,enhancesreliability, stock monitoring,and predictive maintenance, making the machine suitable for deployment inschools, workplaces, healthcarecenters, and public facilities.

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