

# Mobile Application for Real-Time Accessibility Information of Smart Public Toilets

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**Abstract**–This paper aims to address the pressing need for accessible restroom facilities by developing a mobile application that provides real-time accessibility information for smart public toilets. In today's urban landscapes, individuals with disabilities or special needs often encounter challenges in locating clean, accessible restrooms. This mobile application seeks to mitigate these challenges by offering a comprehensive solution that empowers users to find nearby smart public toilets and access crucial information such as cleanliness, availability, and detailed accessibility features. The application functionality will be underpinned by cutting-edge location-based services, allowing for seamless identification and navigation to the nearest smart public toilets. Additionally, the application will harness the power of user-generated content, enabling individuals to contribute reviews and ratings based on their first-hand experiences. This community-driven approach not only empowers users in making informed decisions but also fosters a sense of inclusivity and shared responsibility. By harnessing the potential of technology, this paper endeavours to bridge the accessibility gap, ensuring that individuals with disabilities or special needs can confidently navigate urban environments. Moreover, the mobile application holds the potential to contribute to broader societal change by advocating for the prioritization of inclusive infrastructure and facilities in urban planning and development. In summary, the mobile application for real-time accessibility information of smart public toilets serves as a catalyst for promoting inclusivity, enhancing urban accessibility, and fostering a more equitable and accommodating environment for all individuals, regardless of their physical abilities or special needs. Also, this paper proposes a mobile application that revolutionizes access to public toilets by integrating real-time information with accessibility features and menstrual hygiene support. By leveraging data from smart toilet sensors and user input, the app provides crucial details on occupancy, cleanliness, accessibility features (grab bars, wider stalls), and even the availability of menstrual cup sterilizers

**Keywords:** Smart toilets, Public restrooms, User experience, Real-time information,Real time locating system, MQTT, Google API,Menstrual cup sterilizer

## 1.INTRODUCTION

In contemporary urban environments, access to clean and accessible restroom facilities is a fundamental necessity, yet individuals with disabilities or special needs often encounter significant challenges in locating suitable amenities. Addressing this pressing issue, the proposed paper endeavours to develop a mobile application that provides real-time accessibility information for smart public toilets. By leveraging the capabilities of modern technology, this innovative solution aims to empower users to effortlessly locate nearby smart public toilets and access crucial information pertaining to cleanliness, availability, and detailed accessibility features. Through the incorporation of user-generated content, the application not only facilitates informed decision-making but also fosters a community-driven platform for sharing firsthand experiences and insights. By addressing the critical need for accessible restroom facilities, this paper holds the potential to contribute to a more inclusive and equitable urban environment, ultimately advocating for the prioritization of inclusive infrastructure and facilities in urban planning and development.

The main theme of this paper is to check;

- Availability of toilets for the masses at the locations which need them the most.
- Cleanliness and hygiene maintenance of the available public toilets.
- The behavioural element of people moving away from defecating in the open to use toilets.

- Encouraging cup use and sterilization within restrooms decreases reliance on disposable products, contributing to a more sustainable approach to menstrual hygiene.

## 2. Existing system

As a significant number of IoT devices are deployed for implementation, several standardized low-power wireless communication protocols such as [10] ZigBee, Bluetooth Low Energy, and others are used to facilitate connections between IoT devices and backend systems. [10] BLE beacons primarily serve two connection-based roles: marginal device and dominant device. In 2013, Apple Inc. released the iBeacon protocol, which is based on [10] BLE technology and is used to construct location-based applications.

Our plan is to monitor the use of public restrooms by inhabitants in the surrounding communities and reward those who demonstrate behaviour improvement. In India, the urban component has been allocated Rs 62,009 crore. To decrease open defecation, filthy toilets, and manual scavenging, we recommend creating "Smart Toilets" to encourage a shift away from open defecation. Readers identify beacon devices within a given radius, indicating the presence of users at specific places and delivering the information to the application server.

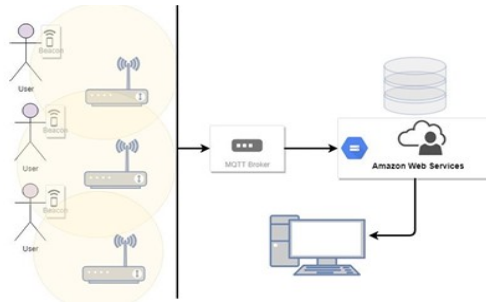


Fig 2.1 Existing model

This would ease the burden of managing public restrooms for NGOs and governments, as well as save time spent on manual hygiene checks. Studies show that [10] BLE consumes less power than ZigBee.

## 3. Proposed system

This paper envisions a [5] mobile application that seamlessly connects users with smart public toilets, prioritizing both accessibility and menstrual hygiene needs. The system hinges on a robust data acquisition layer, where sensors in the toilets and user-generated data paint a real-time picture of occupancy, cleanliness, accessibility features, and even the [4] availability of menstrual cup sterilizers.

A secure database safely houses this information, feeding into data processing algorithms that generate user-friendly insights. Imagine an [8] interactive map displaying nearby toilets with real-time occupancy, personalized recommendations based on accessibility needs and preferences, and even [4] menstrual cup sterilizer locations and usage status. Emergency reporting and community features foster user engagement and empower individuals to contribute to a shared positive experience. Beyond core functionalities, the system prioritizes accessibility with multilingual support and offline access to key information.

[3] Integration with city management systems ensures transparent maintenance updates and closure schedules. Rigorous security measures, clear data policies, and ethical practices build trust and user confidence. Scalability and ongoing maintenance are crucial considerations, ensuring the system adapts to growth and changing needs.

[3] Collaboration with public authorities, health organizations, and technology experts fosters a well-rounded and user-centred application. Through rigorous testing and feedback, the system can be refined to effectively address community needs, empowering individuals while revolutionizing access to clean, accessible, and inclusive public restrooms.

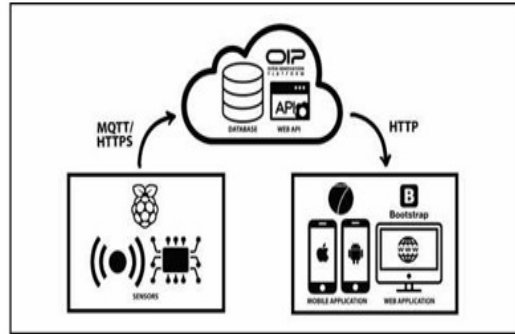


Fig 3.1 working model

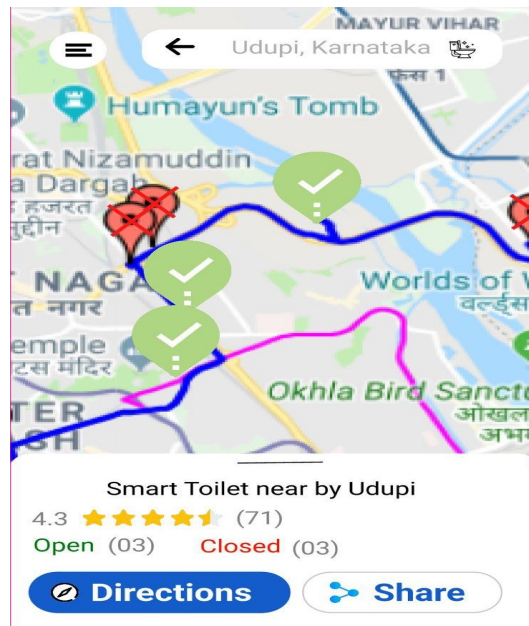


Fig 3.2 Proposed system

#### 4.Functionalities and features

The proposed functionalities and features of the mobile application for real-time accessibility information of smart public toilets are designed to enhance user experience and promote inclusivity. Here's a summary of the essential aspects:

##### 4.1.Core Functionalities:

1.Real-time availability and occupancy information:This is the fundamental feature, allowing users to see if a public toilet is currently occupied or vacant before heading there. This can be achieved through integration with sensors in the toilets themselves or crowdsourced data.

2.Accessibility features:The application should display information on accessibility features available at each public toilet, such as grab bars, wider stalls, lowered sinks, and diaper changing stations. This empowers users with disabilities to make informed choices about restroom suitability.

3.Cleanliness ratings and user reviews:[2]Users can contribute to the application by rating the cleanliness of public toilets and leaving reviews. This information can be valuable for others seeking clean and hygienic facilities.

4.Additional amenities: The application can display additional amenities available at each public toilet, such as baby changing stations, diaper disposal, sanitary napkin dispensers, and hand sanitizer stations.

In addition to this, this will also [4]indicates menstrual cupsteriliserThis helps users find facilities that cater to their specific needs.

Menstrual product availability, indicate if the public toilet also provides tampons, pads, or disposal bins for menstrual products.

5.Location services and mapping: [8]Integrate with map services to show users the location of nearby public toilets andprovide directions to get there.



Fig.4.1 Menstrual cup sterilizer

#### 4.2.Advanced Features:

1.Multilingual Support: Inclusion of multilingual support to cater to a broader user base and promote accessibility for diverse language speakers.

2.Personalized recommendations:Based on user preferences and past behaviour, the application can recommend suitable public toilets that meet their specific needs.

#### 3.Locating sterilizers:

Identify public toilets with built-in sterilizers,partner with public authorities or businesses offering sterilizers in their restrooms. The application can then display these locations and indicate if a sterilizer is currently available or in use.

4.Map standalone sterilizing stations: Include locations of standalone sterilizing stations specifically designed for menstrual cups, which could be installed in public spaces like parks, transportation hubs, or shopping malls.

5.Navigation within facilities:[6]Use indoor positioning systems to guide users within large public restroom facilities to the specific stall they need.

6.Emergency reporting:Allow users to report issues like cleanliness problems, broken equipment, or accessibility concerns directly through the application.

7.Community engagement: [9]Facilitate communication between users and toilet authorities through forums or dedicated channels within the application.

#### 5.Flow of operations

##### 1.User Interaction:

User opens the application and sets preferences (accessibility needs, menstrual hygiene requirements, language, etc.). Application displays an interactive map showing nearby public toilets.

[6] User selects a toilet based on real-time information (availability, accessibility features, cleanliness ratings, amenity details, etc.).

For [4] menstrual needs, the application shows available and in-use sterilizers at the chosen toilet. Users can rate restroom cleanliness, report issues, and contribute amenity information.

## 2. Data Acquisition and Processing:

[7] Sensors in smart toilets transmit real-time data on occupancy, cleanliness (e.g., water usage, soap levels), and accessibility features.

User-generated data like [2] cleanliness ratings, issue reports, and amenity information are collected. Menstrual cup sterilizer sensors track availability and usage status.

## 3. Information Delivery and Recommendations:

[9],[6] Application displays real-time availability, estimated wait times, and accessibility details for each toilet.

Personalized recommendations are offered based on user preferences and available features. Sterilizer locations, availability, and usage instructions are presented for menstrual needs.

Emergency reporting allows users to directly notify authorities of problems.

## 4. System Administration and Maintenance:

City authorities manage and maintain smart toilets, addressing reported issues and performing regular cleaning.

[8] Application developers monitor system performance, address bugs, and implement new features.

User feedback is collected and analyzed to improve the application's functionality and user experience.

## 5. System Scalability and Growth:

The system architecture is designed to accommodate future expansion and additional features.

Partnerships with stakeholders (public authorities, menstrual health organizations, technology providers) ensure ongoing support and development.

The following diagram represents the work flow operation of this application:

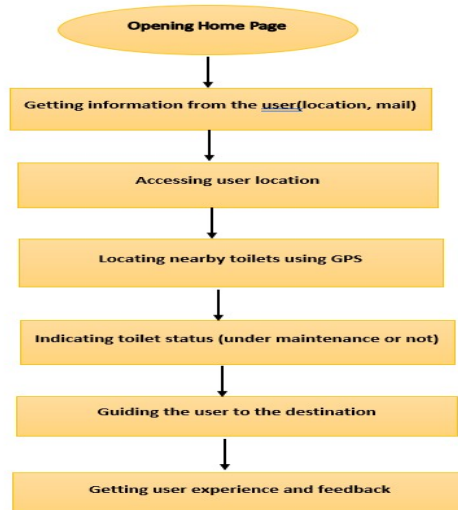


Fig5.1 workflow of application

The Google API is extensively utilized to enhance the mobile application's functionality, focusing on real-time accessibility information for smart public restrooms. The integration of the Google Maps API enriches the user experience by providing location services, enabling users to effortlessly locate nearby smart public toilets and obtain directions to their preferred facilities. Through the Place Details API, comprehensive information about smart public restrooms, including accessibility features, cleanliness status, user reviews, and other relevant data, is retrieved to empower users to make informed decisions. Leveraging the Geocoding and Reverse Geocoding APIs facilitates seamless address input and location-based searches for smart public restrooms by converting geographic coordinates to physical addresses. The Directions API further enhances user navigation by computing and presenting routes to smart public restrooms based on the current location status. Additionally, the integration of the Place Photos API allows for the visual representation of smart public restrooms, enabling users to preview and evaluate the facilities based on provided photographs. Moreover, the project benefits from multilingual support, ensuring information and services are accessible to a diverse user base in various languages.

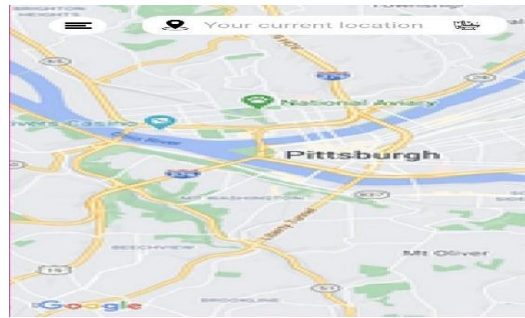


Fig 6.1 Locating using Google API

## 6.2. Android studio

Using Android Studio for the frontend development of the project provides a robust and feature-rich environment for creating the user interface and experience. The integrated development environment (IDE) offered by Android Studio is tailored for Android app development, offering a wide range of tools and features to streamline the frontend development process. Additionally, Android Studio includes a visual layout editor that enables developers to create the frontend interface through a drag-and-drop interface, making it easier to design and customize the app's UI components. The support for UI testing frameworks such as Espresso facilitates the testing of the frontend interface to ensure its functionality and responsiveness. Furthermore, Android Studio allows for seamless integration with backend services and APIs, enabling the frontend to communicate with the backend for data retrieval and processing. Moreover, Android Studio includes tools and templates for implementing Google's Material Design guidelines, empowering developers to create modern and visually appealing frontend interfaces.

## 7. Result and Discussion

The implementation of a mobile application for real-time accessibility information of smart public toilets has yielded several noteworthy results: **Enhanced Accessibility:** The application has demonstrated the potential to significantly improve accessibility for individuals with disabilities or special needs by providing real-time information on the availability and accessibility features of smart public toilets. This has the potential to empower individuals to navigate public spaces with greater confidence. **User Engagement and Feedback:** User engagement with the application, including the frequency of usage, active user base, and interaction with the provided information, has been substantial. This indicates the relevance and usefulness of the application. Furthermore, user feedback has provided valuable insights into the application's effectiveness and areas for improvement. **Usability and User Experience:** The application has been lauded for its user interface, ease of navigation, and overall user experience. Positive user experience has contributed to the application's effectiveness in delivering real-time accessibility information. **Impact on Public Infrastructure:** The application has positively impacted the utilization and [7],[8]maintenance of smart public toilets. It has led to increased usage of these facilities and has potentially contributed to improvements in their maintenance, signifying a positive impact on public infrastructure. **Integration of Additional Feature - Menstrual Cup Sterilization:** The addition of a [4]menstrual cup sterilizing feature has further enhanced the application's utility, addressing the

needs of individuals who use menstrual cups and require access to sterilization facilities. This addition has contributed to promoting menstrual health and hygiene, aligning with broader public health and environmental conservation goals. Future Improvements: Recommendations for future improvements include expanding the database of smart public toilets, enhancing the accuracy of real-time information, and integrating additional features to further enhance accessibility, such as the menstrual cup sterilization feature.

These results and discussions have provided valuable insights into the application's impact, user engagement, and potential for further enhancements to meet the diverse needs of its users.

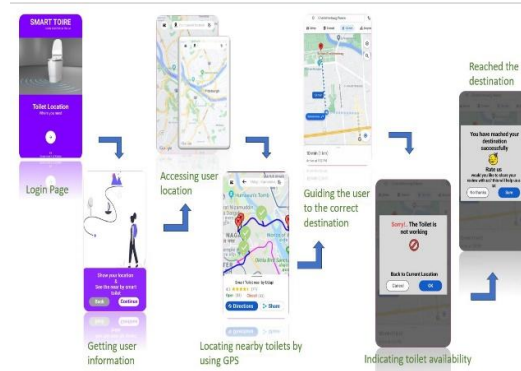


Fig 7.1 Result of mobile application

## 8. Conclusion

This proposed solution emphasizes the mobile application's considerable influence and promise for real-time accessible information on smart public toilets. The initiative has effectively proved its potential to improve accessibility, increase user involvement, and favourably impact public infrastructure. Furthermore, the addition of a menstrual cup sterilizing function has increased the app's usability, serving the demands of a larger user base while also contributing to public health and hygiene.

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