

## Phase-1

### Smart Public Restroom

#### Problem Statement:

Public restrooms, whether in commercial spaces, airports, malls, or public facilities, often face various challenges related to cleanliness, user experience, and resource management. The problem is to create a smart restroom system that addresses these challenges and provides an improved and efficient restroom experience for both users and operators.

#### Key Challenges:

1. **Cleanliness and Maintenance:** Restrooms require regular cleaning and maintenance. Maintaining cleanliness in high-traffic areas is a significant challenge.
2. **Resource Management:** Efficiently managing resources such as water, paper towels, and soap is essential to reduce waste and operational costs.
3. **User Experience:** Restroom users often face inconveniences such as long wait times, empty soap or paper towel dispensers, or unclean facilities.
4. **Accessibility:** Ensuring that restrooms are accessible to all, including individuals with disabilities, is a priority.
5. **Energy Efficiency:** Reducing energy consumption while ensuring proper lighting, ventilation, and temperature control is essential.
6. **Security and Safety:** Restrooms should be secure spaces, and the safety of users should be a top concern.
7. **Feedback and Monitoring:** Gathering user feedback and monitoring restroom conditions in real-time to address issues promptly is critical.
8. **Privacy:** Maintaining user privacy and data security in a smart restroom system is crucial.

#### Challenges

- Cost
- Privacy Concerns
- Integration
- Maintenance
- User Acceptance
- Accessibility
- Data Security
- Energy Consumption
- Scalability
- Regulatory Compliance
- User Training
- Reliability

#### *Solution Objectives for Smart Restroom:*

**1.Enhanced User Experience:** Improve the overall restroom experience for users by reducing wait times, ensuring cleanliness, and providing real-time information about restroom availability and conditions.

**2.Efficient Resource Management:** Optimize the use of resources such as water, soap, paper towels, and energy to reduce waste and operational costs.

**3.Accessibility:** Ensure that the restroom is accessible to all, including individuals with disabilities, by incorporating accessible fixtures, controls, and signage.

**4.Safety and Security:** Enhance restroom security with features like surveillance cameras and emergency response systems while maintaining user privacy.

**5.Data-Driven Insights:** Collect and analyze data from sensors and user feedback to gain insights into restroom usage patterns, enabling data-driven decision-making and predictive maintenance.

**6.Energy Efficiency:** Implement energy-efficient lighting, heating, ventilation, and air conditioning (HVAC) systems while minimizing energy consumption based on occupancy patterns.

**7.Automation:** Automate tasks like refilling soap and paper towels, cleaning schedules, and lighting and HVAC control to reduce manual intervention.

**8.User Feedback Mechanisms:** Enable users to provide feedback through mobile apps or kiosks, facilitating continuous improvement of the restroom experience.

**9.Cost Reduction:** Reduce operational costs associated with maintenance, cleaning, and resource replenishment through efficient management and automation.

**10.Scalability:** Design the smart restroom system to be scalable, allowing it to be implemented in various types and sizes of restrooms.

**11.Regulatory Compliance:** Ensure that the smart restroom system complies with local regulations and codes, including those related to accessibility and data privacy.

**12.Sustainability:** Promote sustainable practices by minimizing resource usage and waste generation within the restroom.

**13.Reliability:** Ensure the reliability of the smart restroom system to minimize disruptions in restroom services.

**14.Environmental Impact:** Reduce the environmental footprint of the restroom by minimizing water usage, energy consumption, and waste production.

**15.User Education:** Provide user training and education on how to use the smart restroom features effectively and safely.

By setting these objectives, the smart restroom system aims to create a cleaner, more efficient, accessible, and user-friendly restroom environment while also promoting sustainability and compliance with relevant regulations.

## **Design thinking**

*Design thinking for a Smart Restroom involves a user-centered approach to create an innovative and effective restroom experience. Here's a simplified design thinking process tailored to this context:*

**1. Empathize (Understand Users and Needs):** Conduct user research: Interview restroom users and stakeholders to understand their pain points, preferences, and expectations. Observe restroom usage: Spend time in existing restrooms to gain firsthand insights into user behavior and issues. Identify key personas: Create user personas to represent different restroom user groups, considering factors like age, gender, and accessibility needs.

**2. Define (Frame the Problem):** Synthesize research findings to identify common problems and opportunities. Define the specific challenges and pain points that the smart restroom solution needs to address. Develop a clear problem statement based on user needs and business goals.

**3. Ideate (Generate Solutions):** Brainstorm creative ideas and potential features that could improve the restroom experience. Encourage a diverse team to contribute ideas, considering both technological and non-technological solutions. Use techniques like ideation sessions, mind mapping, and storyboarding to visualize concepts.

**4. Prototype (Create and Test):** Create low-fidelity prototypes of the smart restroom features and interfaces. Test these prototypes with users to gather feedback and refine the design. Iterate on the prototypes to align them more closely with user needs and preferences.

**5. Test (Gather Feedback):** Conduct user testing with realistic prototypes to evaluate usability and user satisfaction. Gather feedback from users and stakeholders to understand what works well and what needs improvement. Make necessary adjustments based on user input and testing results.

**6. Implement (Build and Deploy):** Develop the final smart restroom system based on the refined prototype. Ensure that the system integrates seamlessly with existing restroom infrastructure. Test the complete system rigorously before deployment to ensure reliability and functionality.

**7. Evaluate (Measure Impact):** Continuously monitor the smart restroom system's performance after deployment. Collect data on restroom usage, resource consumption, user feedback, and maintenance needs. Use data analytics to measure the impact of the smart restroom system on user experience, resource efficiency, and cost savings.

**8. Iterate (Continuous Improvement):** Based on ongoing data analysis and user feedback, make iterative improvements to the smart restroom system. Keep the system up-to-date with evolving user needs and technological advancements.

*Throughout the design thinking process, collaboration among designers, engineers, facility managers, and end-users is crucial. The goal is to create a smart restroom that not only meets users' needs but also adapts to changing requirements and delivers a consistently positive restroom experience.*

### **Coding with Explanation**

*Creating a complete smart restroom system involves a complex set of technologies and components, and it's not feasible to provide a full code implementation here. However, I can give*

*you a simplified example of how to create a basic smart restroom monitoring system using Python and IoT (Internet of Things) concepts. This example focuses on occupancy monitoring and uses a Raspberry Pi and a PIR motion sensor.*

```
# Import necessary libraries
```

```
Import RPi.GPIO as GPIO
```

```
Import time
```

```
# Set up GPIO for PIR sensor
```

```
PIR_PIN = 17
```

```
GPIO.setmode(GPIO.BCM)
```

```
GPIO.setup(PIR_PIN, GPIO.IN)
```

```
# Function to detect motion
```

```
Def motion_detected(channel):
```

```
    Print("Motion detected in the restroom!")
```

```
# Add an event listener for the PIR sensor
```

```
GPIO.add_event_detect(PIR_PIN, GPIO.RISING, callback=motion_detected)
```

```
Try:
```

```
    Print("Smart Restroom Monitoring System is running...")
```

```
    While True:
```

```
        # Your main code logic can go here
```

```
        Time.sleep(1)
```

```
Except KeyboardInterrupt:
```

```
    Print("Smart Restroom Monitoring System stopped by user.")
```

```
Finally:
```

```
    GPIO.cleanup()
```

**Explanation:**

*Import the necessary libraries: We import the RPi.GPIO library for working with the Raspberry Pi GPIO pins. Set up GPIO for the PIR sensor: We specify the GPIO pin (in this case, pin 17) to which the PIR motion sensor is connected. Define a function (motion\_detected) to handle motion detection events. In a real smart restroom system, this function could trigger various actions, such as turning on lights, recording occupancy data, or sending alerts. Add an event listener for the PIR sensor: We use GPIO.add\_event\_detect to monitor the specified GPIO pin for rising edges (motion detected events). When motion is detected, the motion\_detected function is called. Create a main loop: The main loop keeps the program running and allows you to implement additional smart restroom features and logic. In a real system, you'd integrate this with other sensors, database storage, and user interfaces. Handle KeyboardInterrupt: The program can be stopped by the user by pressing Ctrl+C. We clean up the GPIO pins to ensure they're released properly.*

*This example demonstrates a simple aspect of a smart restroom system—motion detection. In a comprehensive implementation, you'd integrate more sensors, data storage, and user interfaces, as well as develop the logic to control lighting, ventilation, and other systems based on occupancy and environmental data. Additionally, you'd consider security and privacy measures, scalability, and integration with a central monitoring system.*