# PHASE 1

## PROBLEM DEFINITION AND DESIGN THINKING

### Problem Definition:

Public restrooms are essential facilities in urban areas, commercial spaces, transportation hubs, and public venues. However, maintaining the cleanliness, hygiene, and efficient operation of public restrooms can be challenging. To address these issues and enhance the user experience, a smart public restroom system is proposed. The problem at hand is to design, develop, and implement a Smart Public Restroom System that leverages technology to improve cleanliness, accessibility, and user satisfaction while optimizing operational efficiency. This system should address various challenges commonly associated with public restrooms.

Challenges:

- Hygiene and Cleanliness
- User Experience
- Accessibility
- Energy Efficiency
- Maintenance Efficiency
- Data Analytics and Reporting
- Security and Privacy
- Sustainability

Solution Objectives:

The objectives of the Smart Public Restroom System are to:

- Improve restroom cleanliness and hygiene.
- Enhance the user experience by providing real-time information and touchless amenities.
- Ensure accessibility for all users.
- Optimize energy and resource usage for sustainability.
- Streamline maintenance processes and resource allocation.
- Collect and analyze data for continuous improvement.
- Maintain data security and privacy.
- Comply with all relevant regulations and standards.

### Design Thinking:

Building a smart public restroom involves several steps . Here’s high level overview of the process:

1. Needs Assessment:
   Understand the specific requirements of the public restroom, such as location, foot traffic, and user demographics.

2. IoT Sensors:
   Install IoT sensors for occupancy detection, toilet paper and soap level monitoring, and real-time cleanliness assessment.

3. Automated Cleaning:
   Implement automated cleaning systems triggered by occupancy data or scheduled maintenance.

4. Touchless Fixtures:
   Install touchless faucets, soap dispensers, and hand dryers to minimize physical contact.

5. Occupancy Indicators:
   Display real-time occupancy status outside the restroom to guide users.

6. Energy Efficiency:
   Use energy-efficient lighting and HVAC systems with occupancy-based controls to reduce energy consumption.

7. Smart Dispensers:
   Opt for smart dispensers that dispense the right amount of soap and paper towels to reduce waste.

8. Maintenance Alerts:
   Set up a system to automatically alert maintenance staff when supplies are low or when cleaning is needed.

9. Security:
   Ensure data privacy and security for IoT devices and data collected.

10. User Feedback:
    Collect feedback from users through digital interfaces to improve the restroom experience.

11. Monitoring and Analytics:
    Implement analytics to track restroom usage patterns, identify issues, and optimize cleaning schedules.

12. Accessibility:

Make the restroom accessible to people with disabilities, including features like accessible stalls, grab bars, and automatic doors.

13. Mobile App Integration:

Develop a mobile app that provides real-time restroom availability information and allows users to request maintenance.

14. Regular Maintenance:

Establish a routine maintenance schedule to ensure all smart restroom components function correctly.

15. Cost Analysis:

Continuously assess the cost-effectiveness of the smart restroom solution and make adjustments as needed.

16. Promotion and Education:

Educate users about the benefits of the smart restroom, such as hygiene and sustainability.

17. Sustainability:

Integrate eco-friendly features like low-flow toilets and water-saving technologies to reduce water usage.

18. Regulatory Compliance:

Ensure compliance with local building codes and regulations for public restrooms.

19. Scalability:

Consider scalability for larger public facilities or multiple restroom locations.

## CODING WITH EXPLANATION

### Coding and Explanation:

A smart public restroom system involves a combination of hardware and software components. Below, I'll provide an overview of the coding aspects for a basic smart restroom system using Python as an example language. Please note that this is a simplified explanation, and a real-world implementation would require more extensive coding and possibly the use of microcontrollers or IoT platforms.

1. Occupancy Detection:

Use motion sensors or occupancy sensors to detect when someone enters or exits the restroom . Write Python code to interface with these sensors and trigger events when occupancy changes.

```
import RPi.GPIO as GPIO
import time

SENSOR_PIN = 17

GPIO.setmode(GPIO.BCM)
GPIO.setup(SENSOR_PIN, GPIO.IN)

def on_occupancy_change(channel):
   if GPIO.input(SENSOR_PIN):
      print("Restroom occupied")
   else:
      print("Restroom vacant")

GPIO.add_event_detect(SENSOR_PIN, GPIO.BOTH, callback=on_occupancy_change)

try:
   while True:
      time.sleep(1)
except KeyboardInterrupt:
   GPIO.cleanup()
```

2. Automated Cleaning:

Implement a scheduled cleaning system or trigger cleaning based on occupancy data . Use Python to control cleaning equipment such as robotic cleaners.

3. User Feedback and Alerts:

Create a user interface (e.g., a touchscreen display) to collect feedback and display alerts . Use Python and a GUI library like Tkinter to design the interface.

```
import tkinter as tk

def submit_feedback():
   feedback = entry.get()
   # Process and store feedback
   print("Feedback submitted:", feedback)

root = tk.Tk()
root.title("Restroom Feedback")

label = tk.Label(root, text="Please provide feedback:")
label.pack()

entry = tk.Entry(root)
```

```
entry.pack()

submit_button = tk.Button(root, text="Submit Feedback", command=submit_feedback)
submit_button.pack()

root.mainloop()
```

4. Data Analytics:

Use Python libraries like pandas and matplotlib to analyze restroom usage patterns and generate reports.

```
import pandas as pd
import matplotlib.pyplot as plt


# Load occupancy data from a database
data = pd.read_csv('occupancy_data.csv')


# Analyze and visualize occupancy patterns
# Example: Create a occupancy chart
data['Timestamp'] = pd.to_datetime(data['Timestamp'])
data.set_index('Timestamp', inplace=True)


plt.plot(data.resample('H').mean())
plt.xlabel('Time')
plt.ylabel('Occupancy')
plt.title('Restroom Occupancy Over Time')
plt.show()
```

This is just a basic overview of coding components for a smart public restroom system. In practice, you'd need to integrate all these elements into a cohesive system, possibly using a microcontroller (e.g., Raspberry Pi) for hardware control, a database for data storage, and a web-based dashboard for monitoring and control. Additionally, you'd need to consider security and data privacy aspects for a real-world deployment.