SMART PUBLIC RESTROOM

PROBLEM STATEMENT:

In densely populated urban areas, the existing public toilet infrastructure often falls short in providing a clean, safe, and efficient sanitation solution. Current public toilets are plagued by issues such as unhygienic conditions, lack of timely maintenance, long wait times due to insufficient availability information, and limited accessibility for people with disabilities. This results in discomfort and inconvenience for residents and tourists alike.The need for improved public toilets is further exacerbated by environmental concerns related to water and energy wastage. Traditional public toilets are often inefficient in resource management, leading to unnecessary water consumption and energy usage.

PROBLEM IDENTIFIED:

Smart public toilets are equipped with various sensors and automated systems. However, these systems require regular maintenance to ensure they function correctly. Sensor malfunctions, clogs, or other technical issues can lead to unhygienic conditions or system failures. With the inclusion of surveillance cameras in smart public toilets for security purposes, user privacy concerns may arise. Striking a balance between security and privacy is essential.While smart public toilets aim to improve accessibility, they may still pose challenges for people with disabilities. This is especially problematic in areas with poor network coverage.Smart public toilets may be susceptible to vandalism or theft of sensors and equipment, which can result in costly repairs and replacements.

INTRODUCTION:

A smart public toilet is a modern and innovative sanitation facility designed to offer enhanced hygiene, convenience, and efficiency in public spaces. These facilities integrate advanced technologies and features to improve the overall public restroom experience. Key components typically include automated flushing and cleaning systems, touchless fixtures, real-time occupancy monitoring, and various sustainable features. Smart public toilets are designed to meet the growing demand for clean and safe restroom facilities in urban areas, promoting better public hygiene and enhancing the quality of life for city residents and visitors. Additionally, they often contribute to environmental sustainability through water and energy-saving mechanisms. These facilities represent a step forward in urban planning and technology integration, addressing a fundamental aspect of urban living: accessible and efficient sanitation.

LITRATURE SURVEY

1.MONITORING AND PREDICTING:

Monitoring and predicting in smart public restrooms based on IoT technology is a dynamic process that harnesses real-time data collection and predictive analytics to enhance multiple facets of restroom operation. Through occupancy sensors, these smart restrooms continuously monitor stall occupancy, enabling the prediction of peak usage times and optimizing cleaning and maintenance schedules. Resource management, from water and energy usage to soap and paper supplies, benefits from real-time monitoring while predictive algorithms anticipate consumption patterns, promoting

efficient resource allocation. Environmental sensors keep a close eye on air quality and comfort factors, with predictive models adapting ventilation and climate control systems according to projected conditions and occupancy. User experience is continually assessed with user feedback mechanisms and satisfaction ratings, offering valuable insights for ongoing improvement efforts.

2.OVERVIEW OF IOT BASED SMART PUBLIC RESTROOM:

An IoT-based smart public restroom represents a revolutionary advancement in the management and operation of public sanitation facilities. This innovative system integrates the power of the Internet of Things (IoT) to create a comprehensive and efficient solution for monitoring, managing, and enhancing the user experience in public restrooms. At its core, IoT sensors and devices are strategically deployed throughout the restroom to collect real-time data on various aspects, including occupancy, resource usage, environmental conditions, and user feedback.

3.IOT BASED SMART PUBLIC RESTROOM MONITERING SYSTEM:

IoT sensors are deployed within the restroom to monitor various parameters. These include occupancy sensors to detect usage, environmental sensors for air quality, temperature, and humidity, and supply sensors to monitor consumables like toilet paper and soap.The data collected from sensors is processed and analyzed to gain insights into restroom usage patterns.Maintenance staff can be alerted when fixtures need repair or restocking, ensuring that the restroom remains in optimal condition. IoT-based restrooms can significantly reduce resource wastageIoT-based smart public restrooms represent a significant advancement in urban infrastructure and contribute to improved public hygiene, resource conservation, and a better quality of life for city residents and visitors. They demonstrate the power of technology in addressing fundamental aspects of urban living and are a reflection of the smart city initiatives seen in many modern urban areas.

4.IOT BASED SMART PUBLIC RESTROOM MONITERING SAND PREDICTION :

An IoT-based smart public restroom monitoring and prediction system represents a groundbreaking approach to optimizing public restroom management. This system leverages a network of IoT sensors and devices to provide real-time monitoring, predictive insights, and improved user experiences. Occupancy sensors enable real-time tracking of stall availability, reducing wait times and improving user convenience. Resource management is enhanced through the continuous monitoring of water and energy consumption, with automated control of restroom fixtures. Environmental sensors maintain an ideal atmosphere by monitoring air quality, temperature, and humidity. Hygiene and sanitation are prioritized through sensors that monitor soap and paper supply levels, ensuring timely restocking.User experiences are elevated with real-time occupancy indicators and touchscreen displays, enabling users to make informed choices about stall availability.

5.IOT-BASED SMART PUBLIC RESTROOM MANAGEMENT SYSTEMS FOR RESIDENTIAL BUILDINGS IN INDIA:

Resource management in terms of water and energy can be optimized by tracking consumption and automating fixtures, contributing to environmental conservation and cost savings. Moreover, environmental sensors can maintain a comfortable and healthy atmosphere within the restrooms by monitoring factors like air quality and temperature.Hygiene and sanitation, particularly in densely populated residential areas, can benefit from IoT-based sensors that monitor soap and paper supply

levels and trigger alerts for timely restocking. User experiences are elevated through real-time occupancy indicators, reducing wait times and enhancing overall satisfaction.Predictive maintenance models ensure that restroom fixtures are always in working order, minimizing downtime.

6.SMATR PUBLIC RESTROOM MONITORING: FROM CONVENTIONAL TO EMERGING TECHNOLOGIE:

The evolution of conventional public restrooms to smart public restrooms powered by emerging IoT technologies represents a significant leap forward in sanitation and user experience. Traditional public restrooms have long struggled with issues such as hygiene, maintenance, and user convenience. However, the integration of IoT technology has paved the way for a transformative shift in this space.Smart public restrooms incorporate a range of advanced sensors and devices, with occupancy sensors at the forefront. These sensors relay real-time data on stall availability, reducing wait times and frustration for users. Emerging technologies such as predictive analytics enable the system to anticipate peak usage times and proactively manage cleaning and maintenance schedules.This leads to cleaner and more user-friendly facilities. User experiences are further enhanced through touchscreen displays and real-time occupancy indicators, ensuring that users can easily find available stalls.The transition to smart public restrooms also brings predictive maintenance models into play.

7.INTERNET OF THINGS (IOT) BASED SMART PUBLIC RESTROOM QUALITY MONITORING SYSTEM:

User feedback mechanisms and data analytics provide valuable insights, empowering authorities to make informed decisions and improvements. Privacy and data security measures are diligently upheld, ensuring user information remains protected. Incorporating energy-efficient practices and accessibility features further solidifies the system's holistic approach, addressing both environmental concerns and the needs of individuals with disabilities.In conclusion, IoT-based smart public restroom systems not only redefine public restroom management but also contribute to cleaner, safer, and more user-centric facilities, resource conservation, and enhanced user satisfaction. This innovative solution aligns with the growing demand for more efficient and technologically advanced sanitation practices in today's urban environments.

8.IOT WATER ENVIRONMENT MONITORING SYSTEM BASED ON LORA:

At the heart of this system lies a network of IoT sensors and devices strategically placed throughout the public restroom. These sensors collect real-time data on various aspects, including occupancy, resource usage, environmental conditions, and user feedback. Occupancy sensors are a key feature, allowing users to instantly check stall availability and reducing wait times.Furthermore, the integration of energy-efficient practices and accessibility features adds to the holistic approach of this system, addressing both environmental concerns and the diverse needs of users. In summary, an IoT-based smart public restroom system in housing societies redefines public restroom management, delivering cleaner, safer, and more user-friendly facilities while conserving resources and enhancing overall user satisfaction. This innovative solution aligns with the desire for a higher quality of life and more efficient sanitation practices in residential communities.

9.IOT BASED SMART WATER MANAGEMENT FOR HOUSING SOCIETY:

Security and safety are significantly improved through the integration of surveillance cameras and emergency buttons, enhancing the overall safety of residents and visitors. User feedback mechanisms and data analytics provide valuable insights for continuous improvements. Privacy and data security

measures are meticulously implemented to protect user information.Furthermore, the integration of energy-efficient practices and accessibility features adds to the holistic approach of this system, addressing both environmental concerns and the diverse needs of users. In summary, an IoT-based smart public restroom system in housing societies redefines public restroom management, delivering cleaner, safer, and more user-friendly facilities while conserving resources and enhancing overall user satisfaction. This innovative solution aligns with the desire for a higher quality of life and more efficient sanitation practices in residential communities.

10.IMPLEMENTING IOT FOR SMART PUBLIC RESTROOM MANAGEMENT:

Resource management is another pivotal aspect of this transformation. IoT technology enables the control of water and energy consumption through automated fixtures like toilets, faucets, and lighting. This not only conserves valuable resources but also leads to cost savings.Environmental sensors play a crucial role in maintaining a comfortable and healthy restroom environment by monitoring air quality, temperature, and humidity. Hygiene and sanitation are prioritized through sensors that track soap and paper supply levels, triggering timely restocking and ensuring a clean and user-friendly environment.The user experience is elevated through real-time occupancy indicators and interactive displays, allowing users to make informed choices. Predictive maintenance models reduce unexpected disruptions, ensuring that restroom fixtures are consistently in working order.

DESIGN THINKING

Design Thinking Approach

1.Empathize:

- Start by empathizing with the users, including residents, tourists, and individuals with disabilities, to gain insights into their restroom experience.
- Conduct interviews, surveys, and observations to uncover pain points and unmet needs.

2.Problem Statement:

- Define a clear problem statement based on user insights. For example, “How might we create a public restroom that ensures accessibility, hygiene, and user convenience for all, while minimizing resource waste?”

3.Ideate: Generate Innovative Ideas:

- Brainstorm and ideate potential solutions. Involve a diverse team of designers, engineers, IoT experts, and users.
- Explore IoT technologies, sensors, and features that can address the defined problem.

4.Prototype: Create Conceptual Designs

- Develop prototypes and conceptual designs that showcase the proposed IoT-based features.

•Consider features such as occupancy sensors, resource management, environmental monitoring, user feedback mechanisms, and security measures.

5.Test: Gather User Feedback

•Test the prototypes with real users to gather feedback on usability, user-friendliness, and overall satisfaction.

•Iterate and refine the design based on user feedback.

6.Implement: Create the Smart Restroom

•Begin the implementation phase, integrating IoT devices, sensors, and systems as per the refined design.

•Ensure seamless connectivity, security, and privacy measures.

7.Scale and Deploy: Expanding the Solution

•After successfully implementing the smart restroom in one location, consider scaling and deploying the solution to additional public restrooms.

•Adapt the design and features as needed to suit different locations and user requirements.

8.Measure Impact:

•Continuously measure the impact of the smart restroom in terms of resource conservation, user satisfaction, and overall effectiveness.

•Use this data to refine the system and demonstrate its benefits to stakeholders.

THE PROJECT'S OVERVIEW

1.Occupancy Monitoring:

•IoT sensors detect real-time stall occupancy, allowing users to quickly identify available stalls and reducing wait times.

2.Resource Management:

•Automated fixtures control water and energy consumption, conserving resources and reducing operational costs.

3.Environmental Sensors:

•Monitoring air quality, temperature, and humidity ensures a comfortable and healthy restroom environment.

4.Predictive Maintenance:

•Predictive models anticipate maintenance needs, reducing unexpected downtime and ensuring reliable restroom fixtures.

5.Security and Safety:

•Surveillance cameras and emergency buttons enhance user safety and deter security threats.

6.User Feedback and Reviews:

•User feedback mechanisms and data analytics provide insights for continuous improvement.

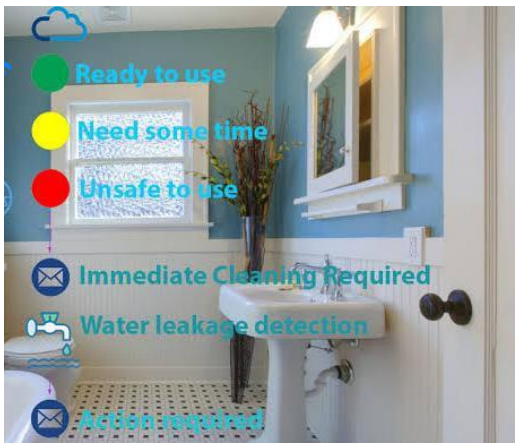
7.Data Privacy and Security:

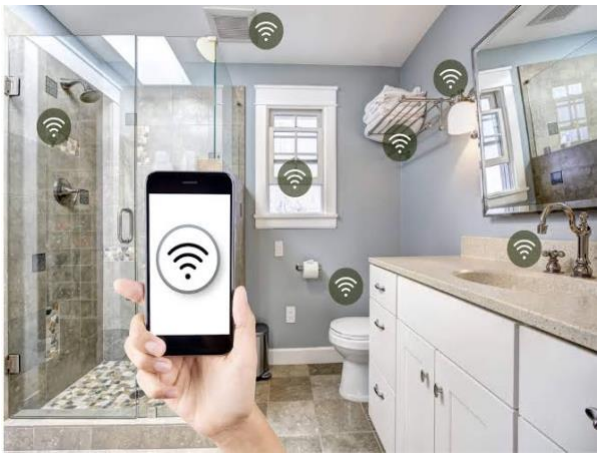
•Robust security measures protect user information and data collected by the IoT devices.

IOT DEVICES SETUP:

COMPONENTS:

Cleanliness sensor:





PLATFORM DEVELOPMENT:

Web Interface:

Choose the programming languages, frameworks, and IoT development tools that align with your project's objectives. Popular choices include Python, Node.js, and IoT platforms like AWS IoT, Google Cloud IoT, or Microsoft Azure IoT.

Server-Side Communication:

•Develop user-friendly interfaces, which can include touchscreen displays, web applications, or mobile apps, for user interaction and feedback submission.

•Implement robust security measures, including user authentication, encryption, and access control, to protect data and prevent unauthorized access.

Hardware Integration:

Communication:

•Establish the connectivity of the IoT microcontroller to the internet. This can be through Wi-Fi, Ethernet, or other suitable methods. Ensure that the connection is secure.

Sensor data transmission:

•Set up the data routing and control logic within the IoT microcontroller to manage data flow and actuation commands.

OVERALL WORKFLOW:

Design the IoT System:

•Develop a detailed system design that includes sensor placement, wiring, connectivity, and data flow.

Develop the Web Interface:

•Create a web interface that provides real-time monitoring, user interaction, and data management. Ensure it is user-friendly and secure.

Installation and Wiring:

•Install the selected hardware and sensors in the public restroom, connecting them to a central control system. Ensure proper wiring and connections.

Configuration and Calibration:

•Configure the IoT devices and sensors, calibrating them for accurate data collection and transmission.

CODE IMPLEMENTATION

Sorce code:

```
Class SmartRestroom:

Def __init__(self):
```

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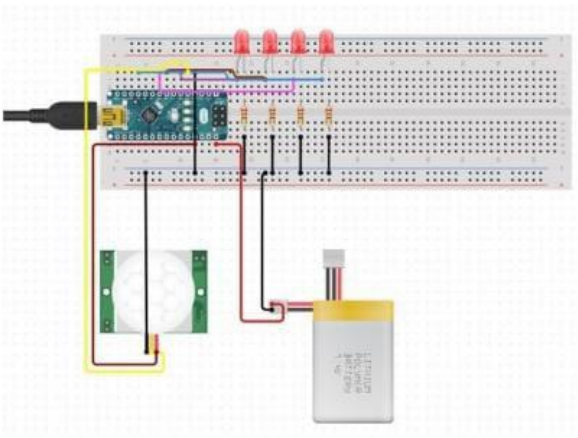
    Self.occupied = False
    Self.paper_towels = 10
    Self.soap_level = 100
Def enter(self):
    If not self.occupied:
        Print(“Welcome to the restroom.”)
        Self.occupied = True
    Else:
        Print(“Sorry, the restroom is currently occupied. Please wait.”)
Def exit(self):
    If self.occupied:
        Print(“Thank you for using the restroom. Please exit.”)
        Self.occupied = False
    Else:
        Print(“No one is currently using the restroom.”)
Def wash_hands(self):
    If self.soap_level > 0:
        Print(“Washing hands… You now have clean hands.”)
        Self.soap_level -= 10
    Else:
        Print(“Out of soap. Please inform the management.”)
Def dispense_paper_towel(self):
    If self.paper_towels > 0:
        Print(“Dispensing paper towel…”)
        Self.paper_towels -= 1
    Else:
        Print(“Out of paper towels. Please inform the management.”)
Def check_status(self):
    If self.occupied:
```

```
            Print(“Restroom is currently occupied.”)
        Else:
            Print(“Restroom is currently unoccupied.”)
        Print(f”Soap Level: {self.soap_level}%”)
        Print(f”Paper Towels Left: {self.paper_towels}”)
If __name__ == “__main__”:
    Restroom = SmartRestroom()
    While True:
        Print(“\nOptions:”)
        Print(“1. Enter restroom”)
        Print(“2. Exit restroom”)
        Print(“3. Wash hands”)
        Print(“4. Dispense paper towel”)
        Print(“5. Check restroom status”)
        Print(“6. Exit”)
        Choice = input(“Select an option: “)
        If choice == “1”:
            Restroom.enter()
        Elif choice == “2”:
            Restroom.exit()
        Elif choice == “3”:
            Restroom.wash_hands()
        Elif choice == “4”:
            Restroom.dispense_paper_towel()
        Elif choice == “5”:
            Restroom.check_status()
        Elif choice == “6”:
            Print(“Exiting the program.”)
            Break
```

Else:

Print(“Invalid option. Please choose a valid option.”)

Circuit diagram:



WEB DEVELOPMENT

Sorce code:

```
<!DOCTYPE html>
<html>
<head>
  <title>Smart Public Restroom</title>
  <link rel=”stylesheet” type=”text/css” href=”styles.css”>
</head>
<body>
  <header>
    <h1>Welcome to the Smart Public Restroom</h1>
  </header>
  <section>
    <h2>Status:</h2>
    <p id=”restroom-status”>Clean and Available</p>
  </section>
  <section>
```

```
    <h2>Occupancy:</h2>
    <p id="occupancy">0 people inside</p>
  </section>
  <button id="clean-button">Start Cleaning</button>
  <button id="occupy-button">Occupied</button>
  <button id="vacate-button">Vacate</button>
  <footer>
    <p>&copy; 2023 Smart Restroom Solutions</p>
  </footer>
</body>
</html>
```

PROJECT EXPLANATION IN DETAILS:

Features/ Components	IoT Powered Restroom Usage Indication System (2020)	IOT Based Smart Cubicle System for Effective Power Usage and Employee Monitoring in Offices (2018)	SMART TOILET: Threats and Challenges Identifying Human Presence using IoT Sensors	**Adopted features in the study**
PIR Sensor to detect human presence	✓	✓		✓
Arduino Implementation	✓			✓
Visualization of Information	✓			✓

Table 1 demonstrates the benchmarking study for the gathered existing systems. The table was able to Identify the common features and components used among the five system as well as the feature or component That would be then adopted in the current system in this study.

Proces Flow:

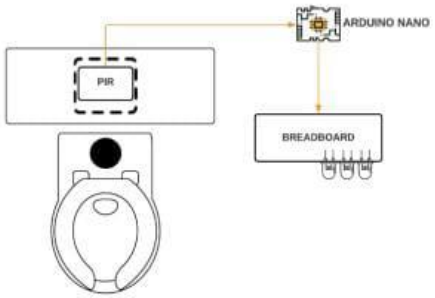


Figure 2 provides visual presentation of the process flow described in the project. The board would be placed In a flat surface above the toilet and facing the door for a more accurate detection range for the sensor. The Board, which is composed of a PIR motion sensor and WIFI module would then relay occupancy information in The cubicle in the indicator.

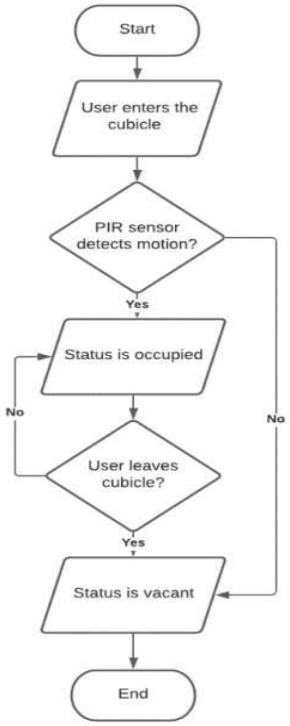


Figure 3 describes the process flow for the project. The process will start when a person enters the cubicle in a restroom with an operating PIR sensor which will be placed on top of the toilet. The heat coming from that human presence would be detected by the PIR sensor and the information would then be processed through the Arduino controller to reflect the occupancy details using simple LED lights. The prototype design was simulated in a simulation platform, Tin.

Cost Specifications:

MATERIAL	QUANTITY	ESTIMATED COST
Arduino Nano R3	1	₱299.75
Breadboard - Full Size	1	₱80.00
Infrared PIR Motion Sensor Module	1	₱94.75
Basic Red LED (5pc pack)	1	₱20.00
220 Ohm Resistor Pack	1	₱20.00
Jumper wires pack (M/M and M/F)	1	₱58.00
Lithium Polymer Battery - 7.4V	1	₱479.12

provides a list of materials to be used in the project and their use in the project. The quantity for each component as well as the estimated cost is also included in this table. Total cost of the project is P1051.62 (in Philippine peso)

Conclusion:

The system design in this study would help improve user experience in public restrooms by eliminating long Waiting lines caused by poor communication on a cubicle's vacancy status. With utilizing the technology of IoT (Internet of Things), the public would be able to use restrooms with ease without worrying about long queues. It Would also help reduce interaction with other people, which in times of the ongoing pandemic, is useful and Could also promote a safe way of using public restrooms by encouraging the public to observe social distancing. Proper information relay about a cubicle's occupancy would also save time as well as increase productivity When it comes to office environments. Some restrictions were made upon the implementation and testing of the system which limited the capacity of The system to visualize information. The current system in the study can only accommodate public restrooms With no more than five cubicles due to the nature of the lack of a portable way of visualizing the processed data. The study made use of LED lights for indicators in each cubicle; if the system were to be implemented in a Bigger environment, it is highly recommended to use other existing IoT platform that enables the wireless Display of information. The use of a WIFI module is preferable to provide a seamless wireless display of Information.