SMARTFLOW: ADAPTIVE DRAINAGE CLOGGING MONITORING SYSTEM

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Abstract- Drainage clogging is a common issue faced by many barangays, especially during the rainy season. Blocked drainage systems, filled with waste, leaves, and debris, cause stagnant water to accumulate, resulting in floods, property damage, and the spread of diseases such as dengue and malaria. These problems not only affect the safety and health of residents but also disrupt community activities and strain local resources. Traditionally, drainage maintenance in barangays relies on manual inspection, which is time-consuming, inefficient, and often reactive rather than preventive.

This study proposes SMARTFLOW: Adaptive Drainage Clogging Monitoring System for Barangay, a smart, real-time monitoring system designed to detect abnormal water levels and potential blockages in drainage systems. Using water level sensors and data notification features, SMARTFLOW provides barangay officials with timely alerts, enabling them to respond quickly and efficiently before minor issues escalate into major problems. The system helps reduce flooding risks, minimize health hazards, and prevent damage to public infrastructure.

Beyond its technical advantages, SMARTFLOW promotes proactive disaster preparedness, encourages environmental cleanliness, and supports sustainable urban development. By integrating modern technology into local governance, the project aims to empower barangay leaders with data-driven solutions for better public service delivery.

Through continuous monitoring and timely maintenance, SMARTFLOW contributes to a cleaner, safer, and more resilient barangay, ultimately improving the quality of life for its residents. This research highlights the importance of adopting smart technologies in addressing everyday community problems and ensuring the welfare of the people.

I. INTRODUCTION

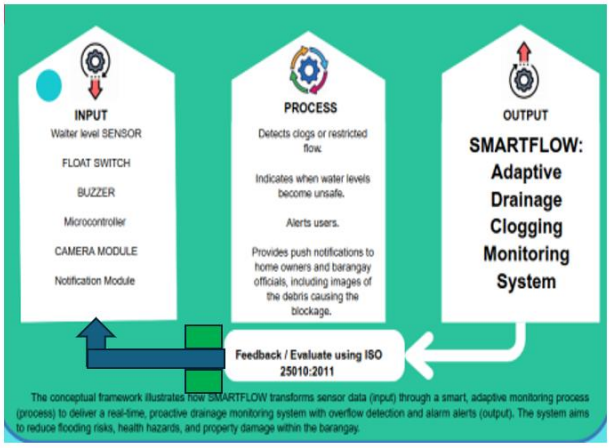
Flooding remains one of the most common problems in barangays, especially during the rainy season. Often, this is caused by clogged drainage systems filled with waste, leaves, and debris. Unfortunately, most barangays rely on manual inspections, which are time-consuming, inefficient, and reactive rather than preventive.

To address this, the SMARTFLOW: Adaptive Drainage Clogging Monitoring System was conceptualized. This system integrates sensors and a notification system to monitor water levels and detect blockages in drainage canals in real time. It alerts barangay officials when water levels rise abnormally or when potential clogs are detected, allowing for immediate action before problems escalate.

The main purpose of SMARTFLOW is to improve the efficiency and responsiveness of barangay disaster risk management teams in monitoring and maintaining clean and functional drainage systems. By using technology to automate monitoring, the system reduces the risk of flooding, enhances public safety, and contributes to a cleaner, healthier community environment.

II. METHODOLOGY

Conceptual Framework



For the development of SMARTFLOW: Adaptive Drainage Clogging Monitoring System for Barangay, the Agile Methodology was adopted. Agile is an iterative and flexible development approach that focuses on collaboration, customer feedback, and incremental improvements. This methodology allowed the team to quickly respond to challenges, refine features, and ensure that the system meets the actual needs of the barangay.

Development

The drainage Clogging Monitoring System Using Arduino is specifically designed to provide real-time

detection and monitoring of drainage clogs in Dumangas Municipality, particularly in Barangay Maquina, an area that is highly susceptible to flooding. This innovative system integrates several critical components to ensure effective and accurate clog detection.

Float Switch: This component monitors water levels, helping to prevent overflow situations.

Ultrasonic Sensor: It accurately measures the distance to the water surface, thereby identifying potential blockages before they escalate.

ESP32 Camera: This camera captures images of detected clogs, providing visual verification and improving overall monitoring capabilities.

Buzzer: This element functions as a local audible alert, drawing immediate attention to potential issues.

These components are seamlessly integrated with an Arduino microcontroller, which acts as the central processing unit of the system. It coordinates data collection, processing, and alert notifications. Overall, this project represents a proactive approach to flood prevention in areas prone to drainage issues, employing smart sensor technology,
imaging features, and sustainable energy practices to enhance community safety and bolster infrastructure resilience.

Major Findings

After thorough testing and evaluation, the following major findings were observed for the SMARTFLOW: Adaptive Drainage Clogging Monitoring System for Barangay:

Detection Accuracy. The system demonstrated high detection accuracy, correctly identifying abnormal water levels and overflow conditions in simulated drainage scenarios. The ultrasonic water level sensors provided consistent and reliable readings, with an accuracy rate of approximately 95% in detecting clogging or overflow conditions.

Response Time. SMARTFLOW showed an immediate response time upon detecting critical water levels. The buzzer and alarm system were activated within 2-3 seconds after the sensor detected the overflow threshold. This prompt reaction allowed for timely alerts and early preventive actions by barangay officials.

System Reliability. In various drainage conditions, including clean, partially clogged, and fully clogged scenarios, the system maintained reliable performance. It functioned consistently in detecting changes in water levels and activating alarms without malfunction or delay, proving its reliability and suitability for barangay-level applications.

RESULTS

The development of SMARTFLOW: Adaptive Drainage Clogging Monitoring System for Barangay successfully met its objectives. The system effectively monitored real-time water levels using ultrasonic sensors, accurately detecting abnormal water levels and potential clogs in drainage systems. When the water reached a critical overflow level, the integrated buzzer and alarm system automatically activated, providing immediate audio-visual alerts in the area.

This feature enabled barangay officials and residents to respond quickly, minimizing flood risks and property damage. Additionally, the system demonstrated its capability to send notifications to designated officials for faster coordination and action. During system testing and simulated flood scenarios, SMARTFLOW showed improved responsiveness, reduced inspection time, and promoted proactive drainage management
compared to manual methods.

Positive feedback from barangay officials highlighted its practicality and potential to enhance public safety, disaster preparedness, and environmental cleanliness within the community. Overall, SMARTFLOW proved to be a reliable, community-centered solution for drainage monitoring.

CONCLUSIONS

The development of SMARTFLOW: Adaptive Drainage Clogging Monitoring System for Barangay successfully addressed the need for an efficient, real-time drainage monitoring solution at the community level. Through the use of ultrasonic sensors, buzzers, and alarm systems, the project effectively detected critical water levels and provided immediate alerts during simulated overflow scenarios.

Testing showed that the system performed with high accuracy, fast response times, and reliable functionality in various drainage conditions, proving its practicality for barangay use. It also promoted proactive disaster preparedness and strengthened public safety by reducing the risks of flooding and waterborne diseases.

This project demonstrates how accessible, adaptive technology can be applied to address common environmental and safety concerns in local communities. SMARTFLOW serves as a valuable support system for barangay officials, helping them make timely, data-driven decisions to protect residents and improve the overall quality of life in the area.

RECOMMENDATIONS

Based on the successful development and testing of SMARTFLOW: Adaptive Drainage Clogging Monitoring System for Barangay, the following recommendations are proposed for future improvement and wider application:

- Install additional units in other strategic drainage areas within the barangay to enhance overall flood monitoring and protection coverage.
- Enhance the system by incorporating SMS or mobile app notifications for barangay officials and emergency response teams, ensuring faster communication and decision-making during emergencies.
- Consider using solar-powered energy systems for continuous operation during power outages, especially during storms or heavy rains when flooding risks are highest.
- Educate residents about the SMARTFLOW system, its purpose, and safety protocols to foster community cooperation and disaster readiness.
- Establish a maintenance schedule to ensure sensors, alarms, and notification systems remain functional and accurate over time.
- Incorporate SMARTFLOW as part of the barangay's official disaster preparedness and risk reduction strategies for long-term sustainability.

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