Edge-AIoT–Based Sustainable Architecture for Optimizing Water Resources in Community Kitchens in Cali, Colombia

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Abstract. This research designs and validates a sustainable Edge-AIoT architecture to optimize water use in community kitchens in Cali, using the Fundación Aprender, Crear y Crecer, which serves 120 people daily, as a case study. Monthly consumption (27,000–42,000 L) exceeds the residential average, mainly in food preparation (42%) and washing. The proposal integrates IoT sensors, edge processing with LSTM and SLMs for real-time prediction, and a local/cloud platform for analysis and visualization. Optimization algorithms generate daily recommendations that improve efficiency and reduce costs. Results show a significant correlation between temperature and consumption (r=0.926). The replicable and scalable model demonstrates how technology applied to the social sphere fosters sustainability, resilience, and responsible water management.

Keywords: GenAI · Community Kitchens · Optimizing · Edge AI

1 Introduction

Access to water is a fundamental human right, particularly vital in vulnerable communities where it ensures health and dignity. In Cali, Colombia, many residents face food insecurity, and community kitchens have become essential spaces to combat this issue. However, their sustainability depends heavily on the efficient use of resources like water. To address this, an Internet of Things (IoT) architecture supported by Edge Computing was developed to monitor and optimize water consumption. The system collects data continuously through sensors, performs predictive processing at the edge, and visualizes results in the cloud to enable real-time decision-making. This approach aims to minimize water waste while informing public policies that promote environmental and economic sustainability.

2 Related Works

Although IoT technologies have been successfully applied in agriculture, energy management, and food waste reduction, few initiatives focus on water consumption in community kitchens. Studies in Egypt, India, and Portugal have integrated IoT for optimizing energy efficiency and minimizing food waste, but water usage remains largely unexplored. Meanwhile, several smart home systems measure water consumption, yet they mainly address domestic or urban contexts. These gaps highlight a significant opportunity to design a scalable IoT platform specifically tailored to water management in socially vulnerable community kitchens.

3 Experiments and results

The IoT system was implemented at the "Aprender, Crear y Crecer Foundation" community kitchen in Cali, where sensors monitored water flow and temperature over a two-year period (2022–2023). A total of 761 daily data entries were analyzed using exploratory data techniques. The monthly average consumption was 1,113 L, with an average temperature of 29.6 °C. The analysis revealed a strong positive correlation (Pearson 0.926) between temperature and water consumption, indicating that higher temperatures lead to increased water use, likely due to intensified kitchen and cleaning activities during warmer months.

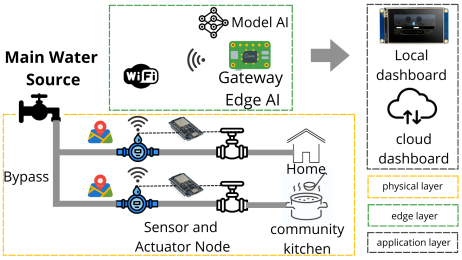

Fig. 1. Experimental scenario with technology stack.

4 Conclusions

This study confirms that combining IoT and Edge Computing technologies provides an effective strategy for optimizing water use in community dining facilities. The proposed system enables continuous monitoring, predictive analysis, and real-time responses, significantly enhancing environmental and economic sustainability. The positive outcomes support scaling the platform to all 762 community kitchens in Cali, offering a robust, replicable model for efficient water resource management and community engagement in sustainability efforts.