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Optimizing Urban Water System Efficiency with Smart Water Grids and IoT Technologies

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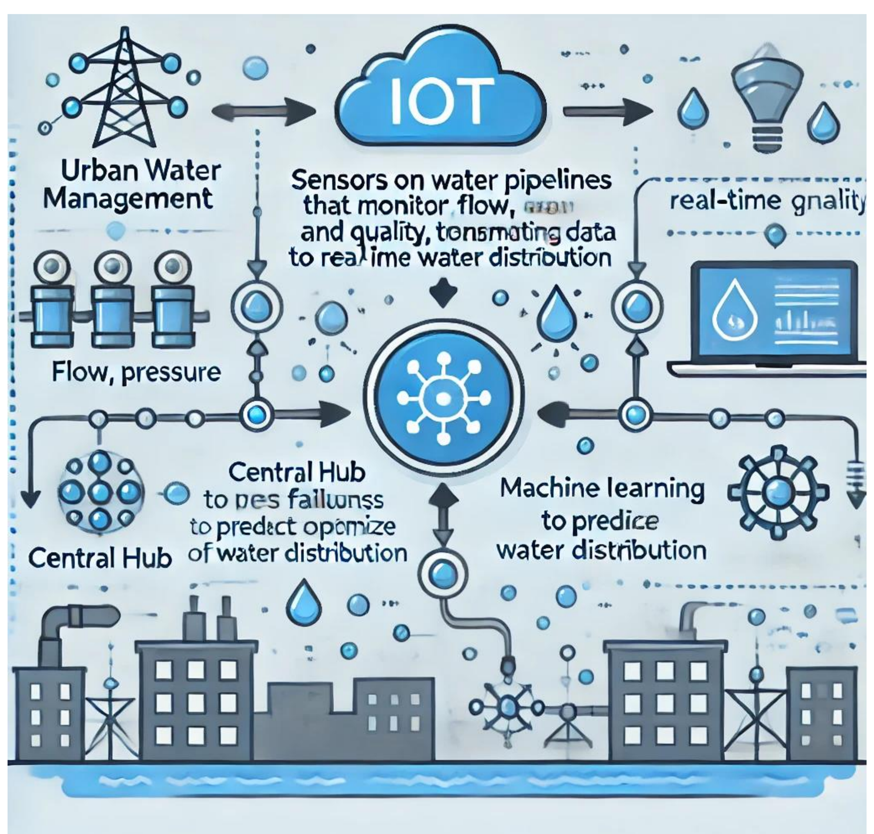
INTRODUCTION & AIM

- **Global Water Crisis:** Urban water systems are under immense pressure due to:
  - **Population Growth**: Expected to reach 9.7 billion by 2050, increasing urban water demand (United Nations).
  - **Aging Infrastructure**: Many cities face water losses of up to 30% due to leaks (World Bank).
  - **Climate Change**: Extreme weather patterns are straining already limited water resources.
  - **30% of urban water** is lost due to inefficiencies, costing billions annually (World Resources Institute).
  - **Rising Demand**: Global water demand is projected to increase by 55% by 2050 (OECD), further pressuring urban systems.
  - **Limited Freshwater Resources:** Only 1% of Earth's freshwater is easily accessible for human use (UNESCO), heightening the need for efficient management.
- **Aim:** To explore how integrating **IoT technologies** and **smart water grids** can:
  - **Enhance real-time monitoring** of water systems.
  - **Predict and prevent system failures**.
  - Improve overall **efficiency and sustainability** of urban water management.

METHODS

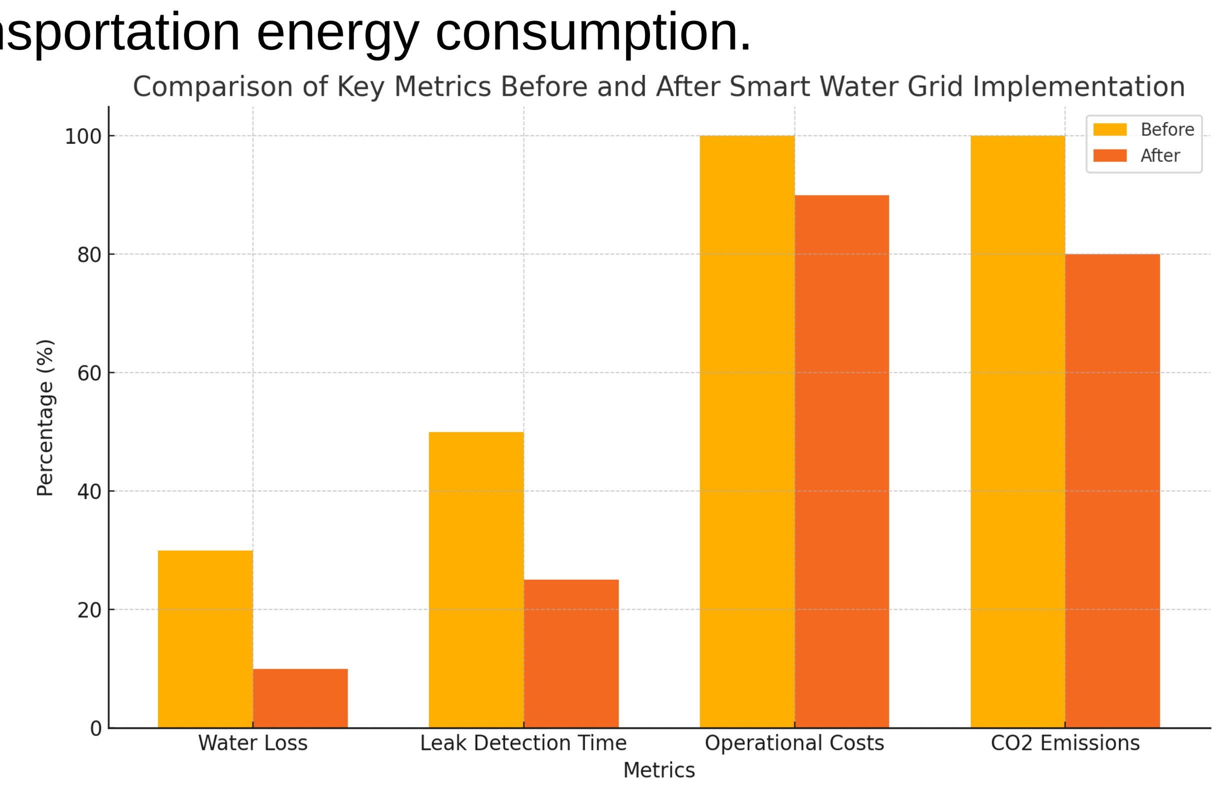
- **IoT Sensors:**
  - Installed at critical points in the water grid to monitor:
    - **Water pressure**, **flow**, and **quality** in real time.
    - Detect leaks and anomalies automatically.
- **Data Collection and Analytics:**
  - Sensors transmit data to a central hub where:
    - **Real-time analytics** processes the information.
    - **Machine Learning Models** are employed to.
      - **predict infrastructure failures**.
      - **Optimize water distribution** to match demand.
- **Geographic Information Systems (GIS)**
  - Used to map **water usage patterns** and pinpoint infrastructure vulnerabilities
  - **GIS data** enables predictions of leaks and automatic water flow adjustments based on real-time data.
- **Data Collection and Analytics:**
  - Applied to:
    - **Predict** leaks before they happen.
    - **Automate adjustments** in water flow based on real-time needs.



RESULTS & DISCUSSION

Theoretical Predictions Based on Prior Studies

- **Reduction in Non-Revenue:**
  - **30% reduction** in water loss is expected, similar to results achieved in Singapore using IoT-based systems.
- **Leak Detection and Repair Efficiency:**
  - **Leak detection time reduced by 50%**, enabling quicker repairs and minimizing water loss.
- **operational Efficiency:**
  - Water management operational efficiency is expected to increase by **25%**.
- **Cost Reduction:**
  - Expected to result in **10% reduction** in operating costs by using predictive analytics to reduce maintenance needs.
- **Environmental Impact**
  - **A 20% decrease in CO_2 emissions** by minimizing water treatment and transportation energy consumption.



CONCLUSIONS

- **Key Findings:**
  - **Smart water grids** integrated with **IoT** and **machine learning** are crucial to:
    - **Reducing water waste**.
    - **Improving distribution efficiency**.
    - **Minimizing operational costs** and **environmental impacts**.
- **Global Impact:**
  - These technologies provide scalable solutions for cities worldwide, promoting:
    - **Resilient urban development**.
    - **Sustainable water management**.

FUTURE WORK

- **Expand IoT Applications:** Extend to rural areas for better conservation.
- **Optimize Machine Learning:** Improve predictive accuracy for system failures.
- **Scale Smart Grids:** Broaden smart grid reach for regional water distribution optimization.

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