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EVALUATION OF TUBEWELL AUTOMATION OF JAGDISHPUR KHAS WATER SUPPY SYSYTEM BY USING WEB SCANET SOAFTWARE

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ABSTRACT

The efficient management of water resources is crucial in ensuring a sustainable water supply for both agricultural and domestic purposes, especially in regions dependent on tube wells. Automation of tube wells offers a promising solution to enhance the reliability, efficiency, and sustainability of water supply systems. This paper presents an analysis of the automation process for tube wells, focusing on the integration of advanced technologies such as sensors, control systems, and IoT (Internet of Things) to optimize water extraction, distribution, and monitoring.

The study explores key aspects of automation, including real-time monitoring of water levels, remote control of pump operations, automated flow regulation, and data-driven decision-making for maintenance and system optimization. The implementation of automated systems significantly reduces human intervention, minimizes energy consumption, and ensures optimal performance under varying water demand conditions. Additionally, the integration of smart sensors allows for predictive maintenance, reducing downtime and enhancing the longevity of infrastructure.

Through case studies and simulation models, this research evaluates the performance improvements, cost savings, and environmental impact of automated tube wells compared to traditional manual operations. The findings suggest that automation leads to more efficient water management, reduced operational costs, and a greater ability to respond dynamically to changes in water supply and demand.

In conclusion, the automation of tube wells offers a transformative approach to water supply systems, promoting sustainability, reducing wastage, and ensuring the continuous availability of water in critical sectors. The analysis highlights the potential for scaling these solutions to larger water management networks, with a broader implication for resource conservation and climate resilience in water-scarce region.

Keywords: 1. Tube Well Automation System, 2. Water flow & Level Sensors 3. Pump Control and Water quality monitoring 4. Remote Monitoring 5. Sustainable Water Management 6. Real-time Data 7. Remote Control Operational Efficiency, 8. Internet of Things (IoT).

I. INTRODUCTION

Access to clean and reliable water is a fundamental requirement for the well-being of rural communities, yet many villages in India continue to face significant challenges in managing their water resources efficiently. Jagdishpur Khas, a village located in Jaunpur District, Uttar Pradesh, relies heavily on groundwater extracted from tube wells for domestic needs. However, like many rural areas, the water supply is often plagued by inefficiencies due to outdated manual systems, and lack of real-time monitoring. These issues can lead to problems such as water shortages, overuse of electricity for pumping and water wastage

In recent years, the need for efficient water management solutions has become more pressing, particularly in regions where groundwater is the primary source of water supply. Automation of tube wells offers a promising solution to address these challenges. By integrating modern technologies such as remote sensing, IoT (Internet of Things)-based monitoring systems, automated control mechanisms, and data analytics, tube wells can be operated more efficiently and sustainably. The automation of water supply systems not only enhances operational efficiency but also helps in reducing energy consumption, and reducing wastage water, minimizing human error and maintain water quality to ensure the supply of good quality of water to every household.

The aim of this study is to analyze the potential benefits and challenges of implementing tube well automation in Jagdishpur Khas village. This research focuses on how automation can improve the monitoring and control of groundwater extraction, reduce dependency on manual intervention, and contribute to more sustainable and efficient water supply practices. The study will examine key aspects such as real-time water level monitoring, automated pumping schedules, and the integration of predictive maintenance technologies to reduce system downtimes and enhance the longevity of the infrastructure.

In this research, automating tube wells in Jagdishpur Khas presents an opportunity to improve the overall efficiency of water supply systems, reduce energy consumption, and ensure more equitable access to water for all residents. This study seeks to demonstrate the transformative potential of automation technologies in addressing the pressing water management challenges faced by rural communities in India.

This Tubewell automation technology implemented under the scheme of Implementation of Jagdishpur Khas Village water supply system under the State water Sanitation Mission (SWSM) under JJM Programme.

Under the mission, the program envisions empowering local communities, improving water quality management, and fostering water conservation practices to ensure the long-term sustainability of water resources.

1.1Aim

The aim of this study to analyses the automation system in water supply schemes, highlighting its significance in enhancing efficiency, reliability, and sustainability. By integrating advanced technologies such as IoT, AI, and data analytics, automated systems facilitate real-time monitoring, remote management, and predictive maintenance. Automation in these systems has emerged as a transformative approach, addressing inefficiencies, reducing water loss, and improving service quality. This study aims to explore the various components of automation systems, their functionalities, and their impact on water supply management.

1.2Objectives

Ensure Consistent and Reliable Water Supply: Automate tube well operations to maintain a steady, uninterrupted water supply with reduced manual intervention.

Enhance Operational Efficiency: Streamline and optimize operations to improve system reliability and reduce operational delays.

Monitor and Improve Water Quality: Implement real-time monitoring systems for water quality to ensure safe and healthy water delivery.

Reduce Water Wastage and Promote Conservation: Automate water flow control to minimize wastage and promote efficient usage.

Enable Remote Monitoring and Control: Provide remote access to monitor and control tube well functions, allowing for real-time data access and improved decision-making.

Support Predictive Maintenance: Set up alerts and notifications to allow for predictive maintenance, extending the system's life and reducing breakdowns.

1.3Outcome Goal

Enhanced Water Supply Efficiency, Reduction in Water Wastage, Lower Energy Consumption, Operational Reliability and Reduced Downtime, Improved System Monitoring and Data Management, Economic Benefits, Enhanced User Satisfaction

1.4Scope

1.4.1 Evaluation of Existing Infrastructure: Assess the current water supply infrastructure, including tube wells, pumps, pipelines, and distribution systems. Identify bottlenecks, inefficiencies, and operational challenges in the current setup.

1.4.2 Feasibility of Automation Technologies: Research suitable automation technologies such as IoT sensors, SCADA systems, and smart meters. Evaluate their feasibility in terms of cost, reliability, and compatibility with the current infrastructure.

1.4.3 Automation System Design: Design a comprehensive automation plan, specifying required components like sensors, controllers, data loggers, and communication systems. Define performance parameters to be monitored, such as flow rate, pressure, water quality, and system health.

1.4.5 Implementation Planning: Develop a phased implementation plan, starting with critical areas like water quality monitoring and pump automation. Create a timeline for implementation, focusing on minimizing disruption to the current water supply.

1.4.6 Cost-Benefit Analysis: Estimate the costs involved in system installation, maintenance, and training. Analyze potential savings from reduced water wastage, energy consumption, and operational efficiency.

1.4.7 Risk Assessment and Mitigation: Identify risks such as power outages, system breakdowns, and cyber threats. Propose risk mitigation strategies to ensure system robustness and data security.

1.4.8 Training and Capacity Building: Assess training requirements for operators to manage and maintain the automated system. Plan a training program covering system operation, troubleshooting, and data interpretation.

1.4.9 Performance Monitoring and Evaluation (M&E): Develop an M&E framework with KPIs such as uptime, water quality consistency, and energy savings.

II. LITERATURE REVIEW

2.1 Viani, F., Bertolli, M., and Rocca, P. (2017). "Water Level Monitoring for Leakage Detection in Smart Cities." Sensors, 17(7), 1571.

This article discusses the use of water level monitoring as part of a broader strategy for leakage detection in the context of smart cities. It focuses on the application of sensor technology for real-time water monitoring, aimed at improving water distribution systems by detecting leaks early and enhancing operational efficiency. Real-time monitoring not only help in reducing water wastage but also improve overall system performance, reduce costs, and contribute to the sustainable use of water resources.

2.2 Singh, R., and Sharma, A. (2019). "Tube Well Automation in Rural India: A Case Study of Punjab." International Journal of Rural Development and Technology, 3(2), 32-40.

provides an in-depth examination of the implementation and impact of tube well automation in rural areas of Punjab, India. The study explores how automating tube wells can address the challenges of water management, improve resource efficiency, and promote sustainability in rural water supply systems. The case study in Punjab demonstrates the viability and benefits of tube well automation in rural India. The implementation resulted in more efficient water and energy usage, improved agricultural productivity, and a sustainable approach to groundwater management. These insights could serve as a model for other rural regions facing similar challenges with water resource management.

2.3 Ali, I., and Hameed, M. (2021). "Sustainable Rural Water Supply through Solar-Powered Tube Wells and Automation." Renewable Energy Journal, 6, 75-84.

explores the integration of solar power and automation technology in tube wells to create a sustainable water supply system for rural areas. This study highlights the potential of solar-powered tube wells combined with automated systems to address water scarcity, reduce dependency on non-renewable energy, and improve water management in rural communities. This article demonstrates the effectiveness of combining solar energy with automation to create a sustainable water supply system for rural areas. Solar-powered, automated tube wells offer significant advantages in energy efficiency, water conservation, and operational cost savings, providing a valuable model for improving rural water access in an environmentally sustainable way.

2.4 CPHEEO, MoHUA, "Advisory on Water Meters, Instrumentation & SCADA", June, 2020.

This document by the Central Public Health and Environmental Engineering Organisation (CPHEEO) under the Ministry of Housing and Urban Affairs (MoHUA) in India, offers a technical advisory on the integration of water meters, instrumentation, and SCADA (Supervisory Control and Data Acquisition) systems in water supply management. Key points include:

Water Metering: Guidelines on selecting, installing, and maintaining water meters to improve usage measurement accuracy.

Instrumentation: Recommendations for deploying sensors for water quality and flow rate monitoring, aiding in real-time water management.

SCADA: Insights on how SCADA systems enable remote monitoring, control, and data analysis for efficient management of municipal water systems.

Application in Urban and Rural Areas: Practical implementation strategies are outlined for both urban and rural settings in India, improving water conservation, reducing losses, and enhancing system reliability.

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2.5 David A. Lloyd Owen (2018) "Smart Water Technologies and Techniques: Data Capture and Analysis for Sustainable Water Management

The article concludes by reinforcing that smart water technologies represent a critical component for achieving sustainable water management in the face of growing urbanization, climate change, and the increasing global demand for clean water. By using advanced data capture and analysis techniques, water utilities can improve operational efficiency, enhance customer service, and contribute to the sustainability of water resources. David A. Lloyd Owen emphasizes that these technologies are not only transforming how we manage water systems but also offering cost-effective solutions that can help address the world's water scarcity challenges.

2.6 Prabhata K. Swamee and Ashok K. Sharma (2007) "Design of Water Supply Pipe Networks"

The article by Prabhata K. Swamee and Ashok K. Sharma focuses on the design principles and methodologies for water supply pipe networks. The primary goal is to provide a comprehensive framework for engineers and water supply professionals to design efficient and effective pipe systems that ensure reliable water distribution across urban, rural, and industrial settings.

Efficient Design: The article concludes that a well-designed water supply pipe network requires a balance between technical, economic, and environmental factors. Proper estimation of demand, appropriate pipe sizing, and maintaining pressure and flow are fundamental to a reliable water distribution system.

Optimization: Engineers are encouraged to use advanced hydraulic analysis tools and optimization methods to ensure that the water supply system operates at its highest efficiency while keeping costs low.

Sustainability: Long-term sustainability is achieved by designing flexible systems that can adapt to future changes in population and demand, and by considering energy-efficient solutions for pumping and distribution.

2.7 Daniel P. Loucks and Eelco van Beek (2017) "Water Resources Systems Planning and Management "

Integrated Management: The book underscores the importance of an integrated approach to water resources management, where different aspects—such as supply, demand, quality, and environmental impact—are considered holistically.

Optimization and Decision Support: It emphasizes that effective planning and management require the use of advanced modelling and decision-support tools, which allow decision-makers to evaluate various scenarios and make informed choices.

Resilience to Change: The authors stress the need for adaptive management strategies that can handle the uncertainties of climate change, population growth, and economic pressures on water resources.

Sustainability Focus: The book promotes sustainable management practices that balance human needs with environmental protection, ensuring that future generations have access to adequate water supplies.

III. LIMITATIONS AND RESEARCH GAP

3.1 Limitations

3.1.1 Technical Challenges in Automation:

Infrastructure and Connectivity: In many rural and remote areas, reliable internet and cellular connectivity are often unavailable, which limits real-time monitoring and control capabilities.

Maintenance Requirements: Automated systems require regular maintenance, calibration, and sometimes specialized skills, which may not be readily available in rural settings.

3.1.2 Energy Efficiency and Power Supply Limitations

Power Supply Variability: Automated tube wells, especially in rural areas, may face challenges due to unreliable electricity. Solar-powered systems can mitigate this, but they also require backup systems for cloudy days or extended rainy seasons.

Energy Consumption Optimization: While automation can enhance water use efficiency, more research is needed on optimizing energy usage in automated systems, particularly in grid-constrained regions.

3.1.3 Cost Barriers

High Initial Setup Costs: Automation infrastructure, including sensors, controllers, and IoT devices, can be prohibitively expensive, limiting accessibility for small-scale or low-income communities.

Limited Data on Long-Term Environmental Impact

Groundwater Sustainability: Automated tube wells can increase pumping efficiency but may also lead to over-extraction of groundwater if not properly regulated, which can contribute to depletion of aquifers.

Environmental Impact of Automation Technology: Research is limited on the long-term environmental impacts, including the energy footprint and waste generated from automation devices (e.g., batteries, electronics).

3.1.5 Data Management and Security Concerns

Data Storage and Analysis: In many cases, real-time data is generated by automated systems, but effective methods for data analysis, storage, and usage in decision-making are underdeveloped.

Cybersecurity Vulnerabilities: Automated systems are susceptible to hacking and data breaches. Research is needed on secure, resilient designs for rural and urban water systems.

3.1.6 User Training and Awareness

Skills Gap: Successful operation and maintenance of automated systems require technical skills that may not be readily available in rural areas. This necessitates continuous training, which has not been widely addressed in current literature.

3.2 Research Gap

The research gaps in the field of tube well automation for rural water supply systems is primarily related to technology adoption, system optimization, and socio-economic considerations. Below are key research gaps.

3.2.1 Integration with Existing Infrastructure:

Adaptation to Legacy Systems: Many rural areas use older tube well systems that were not designed with automation in mind. Research is needed on how to integrate modern automation technologies with these legacy systems without significant overhauls or excessive costs.

Technology Compatibility: A gap exists in studies addressing the compatibility of different automation technologies (e.g., sensors, SCADA, IoT-based controllers) with existing water infrastructure in rural settings.

3.2.2 Cost-Effectiveness and Financing Models

Affordable Automation Solutions: While automation can improve water supply management, the cost of installing sensors, controllers, and automation systems is often high. Research is required to identify cost-effective solutions that can be scaled for rural areas.

Long-term Cost-Benefit Analysis: While automation promises operational savings, there is limited research on long-term economic feasibility in rural contexts, including factors like repair costs, maintenance, and return on investment.

3.2.3 Energy Sources and Efficiency

Sustainable Power Solutions: Tube well automation systems rely on electricity, and in rural areas, the power supply may be unreliable. Research is required on alternative, sustainable energy sources, such as solar-powered automation, and their long-term viability and cost-effectiveness.

Energy-Efficiency Optimization: Studies are needed on optimizing energy consumption in automated systems, especially in off-grid areas, to minimize reliance on expensive or unreliable energy sources.

3.2.4 Water Resource Management

Groundwater Depletion and Regulation: While automation systems can improve efficiency, they may also contribute to over-extraction of groundwater if not monitored carefully. Research is needed on automated systems that can help manage water extraction rates to prevent overuse and depletion of aquifers.

Water Quality Monitoring: Most automation studies focus on water quantity and flow rate, but there is limited research on integrating real-time water quality monitoring (e.g., pH, turbidity, contaminants) into automated tube well systems, which is crucial for ensuring safe drinking water.

3.2.5 Data Management, Security, and Analytics

Data Utilization and Decision-Making: Automated systems generate large volumes of data. Research is needed on how to effectively utilize this data for decision-making in water management, particularly in resource-constrained rural environments.

Data Security and Privacy: With the rise of IoT and cloud-based systems, securing data and ensuring privacy in rural water systems is a critical concern. There is a need for research into robust cybersecurity measures for rural water supply systems.

Predictive Analytics for Leak Detection: Limited research exists on integrating predictive analytics with tube well automation to detect leaks or anomalies early, preventing water loss and system breakdowns.

IV. RESEARCH METHODOLOGY

4.1 Study Design and Data Collection

Study Area Selection: Identify rural regions with active tube well-based water supply systems that are either suitable for automation or are currently in the process of adopting it.

Data Collection:

Identify key data points (water level, pump status, energy consumption, flow rates, groundwater depth, water quality parameters). Use of IoT sensors, SCADA systems, and PLC controls to collect real-time data from tube wells and the associated infrastructure.

Technology Selection and System Design

Objective: To select appropriate technologies for tube well automation based on the local environment, technical requirements, and available resources.

Technologies to Consider:

WEB SCANET Software

SCADA (Supervisory Control and Data Acquisition) for centralized control and monitoring.

PLC (Programmable Logic Controllers) for automation and control of pump operations.

Sensors for monitoring water quality, water levels, and flow rates.

Remote control interfaces for mobile or web-based management.

Renewable energy sources (e.g., solar-powered pumps) to minimize energy costs in off-grid areas.

System Integration: Design the integration of all components (sensors, controllers, communication systems) into a cohesive and scalable automation system.

Implementation of Automation Systems

Software Integration: Implementation of Webscanet software to automate data collection, monitoring, and control processes.

Performance Testing: Comparative analysis of the system's performance before and after automation.

Data Analysis: Continuous monitoring of key metrics such as water flow, energy consumption, and pressure variations.

Key Features of WebScanet Software

Real-Time Monitoring: Captures operational data from sensors installed in tubewells.

Automated Alerts: Provides instant notifications for anomalies or system failures.

Data Visualization: Offers graphical representation of water supply metrics for better analysis.

Control Integration: Enables remote control of tubewell operations through a user-friendly interface

4.4 Site Visit to Jagdishpur Khas village Jaunpur district Uttar Pradesh.

Visited at Jagdishpur Khas village on dated10-10-2024 to review progress work of Automation system.

Objective of the Visit: The objective of this site visit was to assess the ongoing progress of the tube well automation project at Jagdishpur Khas village. The visit focused on checking the status of installation, inspecting the quality of work, evaluating adherence to the project timeline, and identifying any obstacles affecting progress.

Project Overview: This project aims to automate the operation of tube wells in Jagdishpur Khas village to streamline water distribution for domestic purposes. Automation is intended to reduce manual involvement, improve water management, and provide real-time data monitoring capabilities.

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Work Progress details

Equipment Delivery: All major equipment, including pumps, control panels, sensors, and communication modules, has been delivered to the site.

Installation Status:

Pump Installation 10 HP: Completed.

Actuator Valve Installation: Completed.

Control Panels: Installed and wired. The installation completed.

Sensor Setup: Completed.

Chlorination system Installation: Completed.

Communication Modules: Installation completed.

Power Source: Solar power and stand by DG

Solar and DG Installation: Completed.

Testing: Preliminary tests on the control panel and sensors have been conducted. Further testing is planned once the communication modules are fully functional.

Power Supply: Power connections have been established, with backup systems.

4.5 Integration and Mapping and data Monitoring

Complete Sensor Installation: completed.

Install Communication Modules: Complete communication hardware installation for remote monitoring capability.

Final Testing at site: Conduct comprehensive system tests upon installation completion.

Data Integration and Mapping on Web Scanet software

Finaly monitoring the real data on Web Scanet software

Fig.1 Solar Plant (16 KW)

Fig 2. DG 15 KVA

Fig.3 Automation Panel

Fig.4 checking Flow of water

Fig.5 Flow Meter display

Fig.6 Project Model

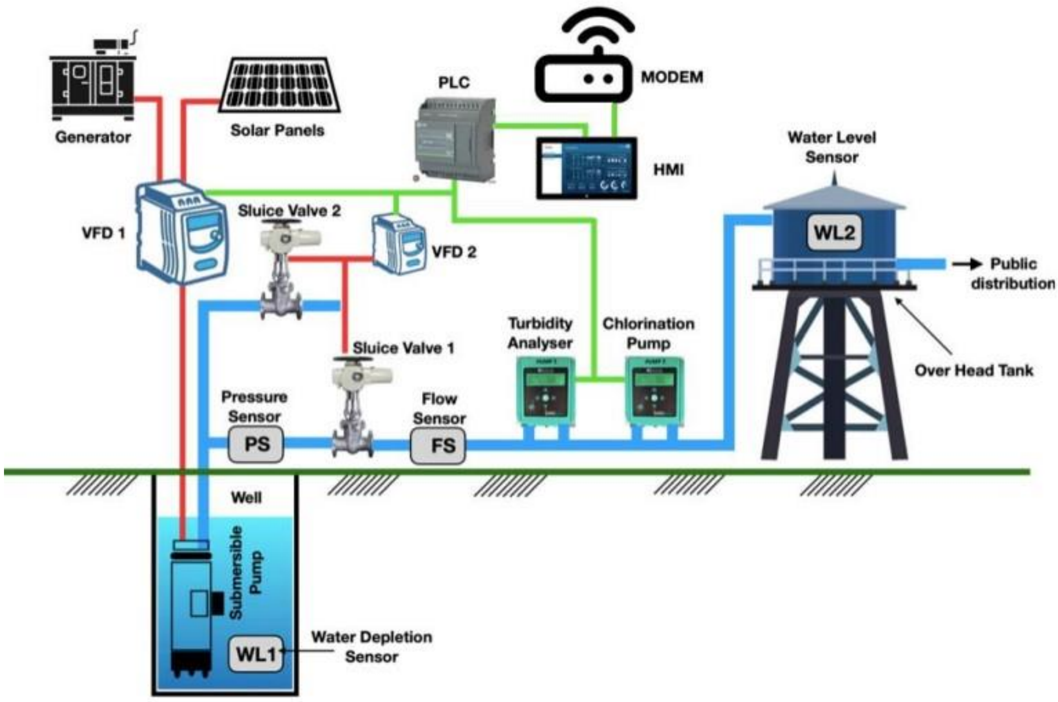

Fig. 7 Tube well Automation system Architecture

The Tubewell Automation Panels are intelligently controlled by a PLC (Programmable Logic Controller) which processes the logic by taking inputs from sensors like Depletion sensor, Pressure Sensor, Flow Sensor & OHT Water Level Sensor, connected to its inputs.

An HMI is provided for viewing the TAP process & manually controlling the Pump-house operations.

It switches the Submersible Pump and the Actuator valves, when the Overhead Tank needs to be filled. It also power-up the Chlorination Dosing for water treatment.

The submersible pump will work through the power supplied from Solar Panels. But in emergency it can also be operated through Diesel Generator supply.

The Tubewell Automation Panel don't need any operator to start / stop pumping. The Panel control remains in always ON condition so that, in the morning it can automatically sense the intensity of solar power & start operations. A UPS keeps its power uninterrupted.

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The PLC communicates all the vital Parameters like Solar Intensity, Water Flow, Water Pressure, Water level, Chlorine level, VFD Trip status & UPS battery level etc., to the MODEM through MODBUS. The MODEM shares all the data with the web server, for analysing & Alarm generation.

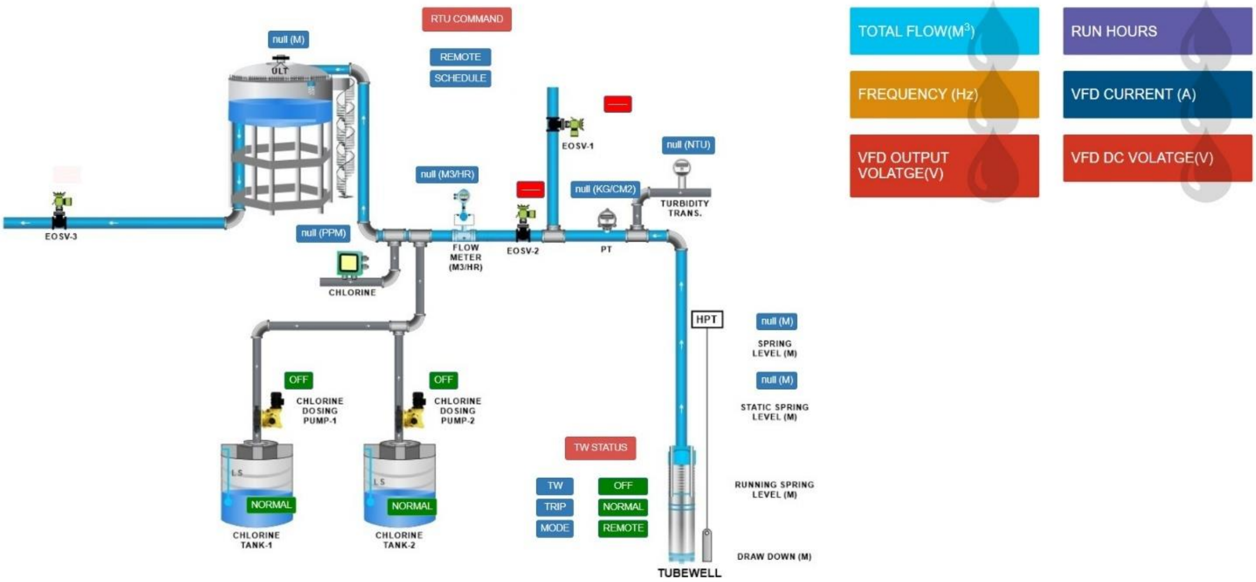


Fig.8 Typical Scada WEB Scanet Software screen.

V. RESULTS

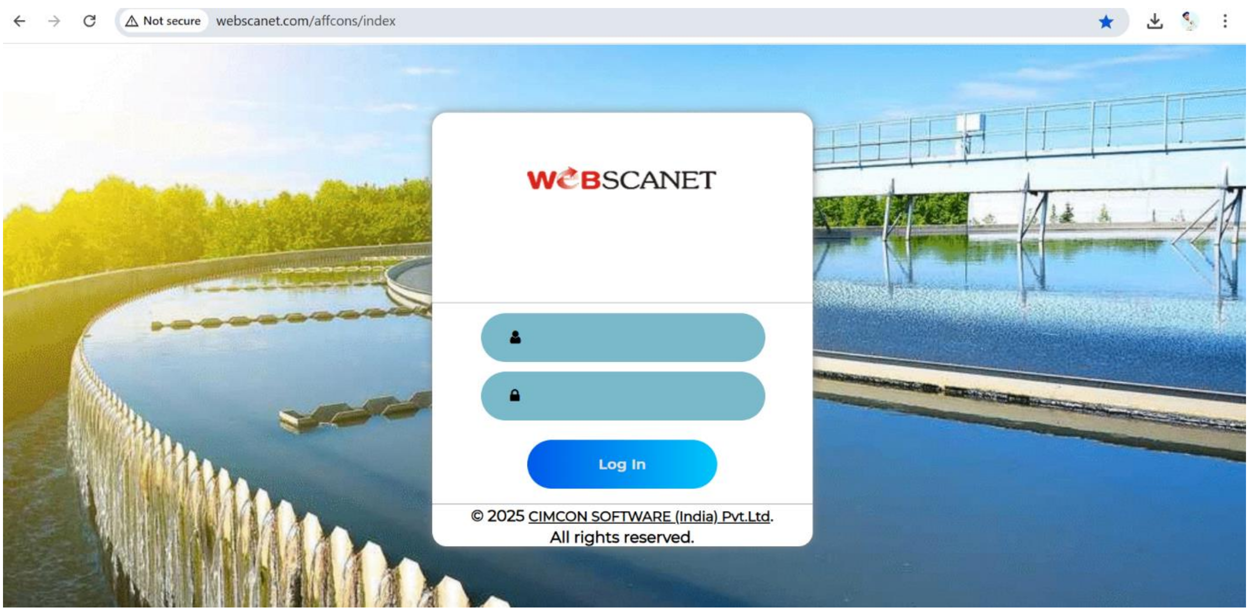
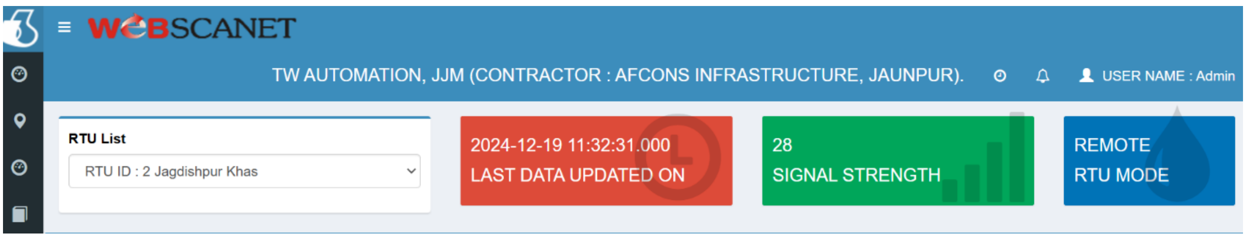


Fig.9 Login Page of WebScanet



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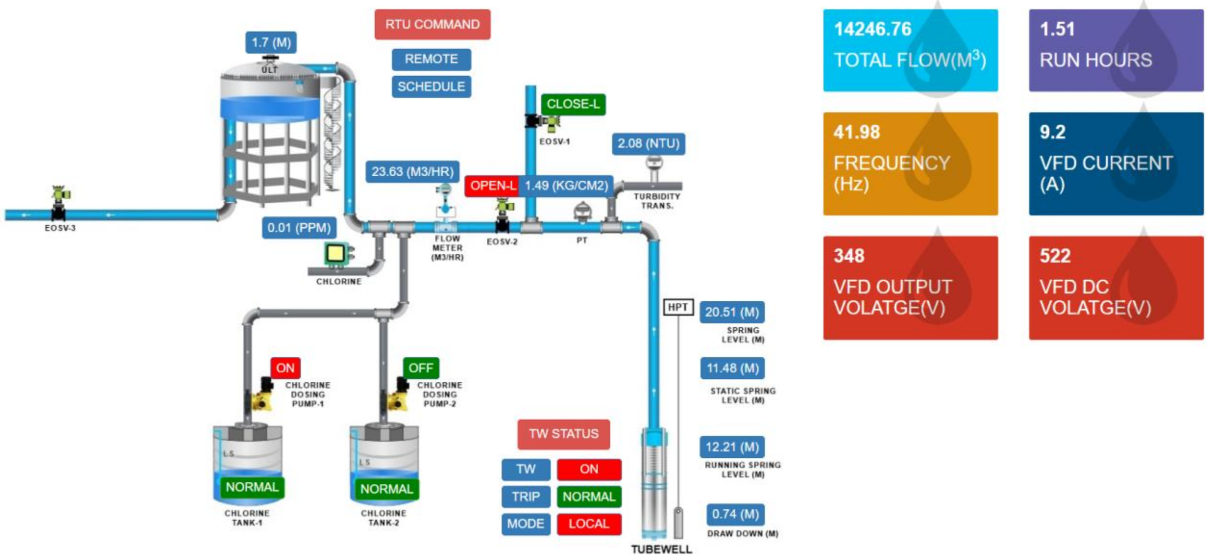

Fig.10 Jagdishpur Khas Scheme Live Dashboard on WEB SCANET

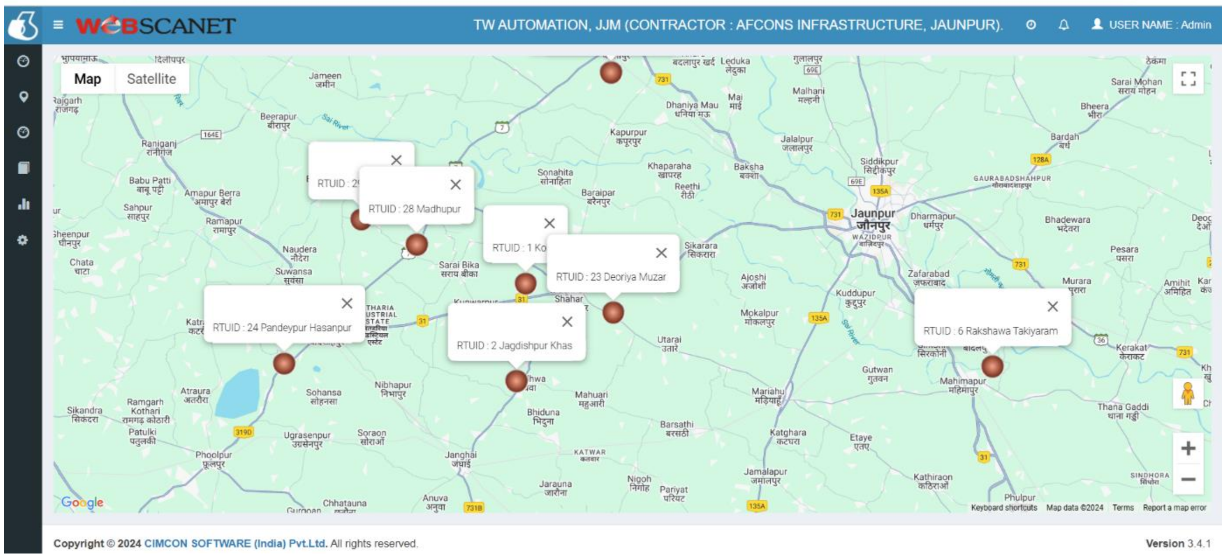

Fig.11 Map/Satellite Integrate on WebScanet.

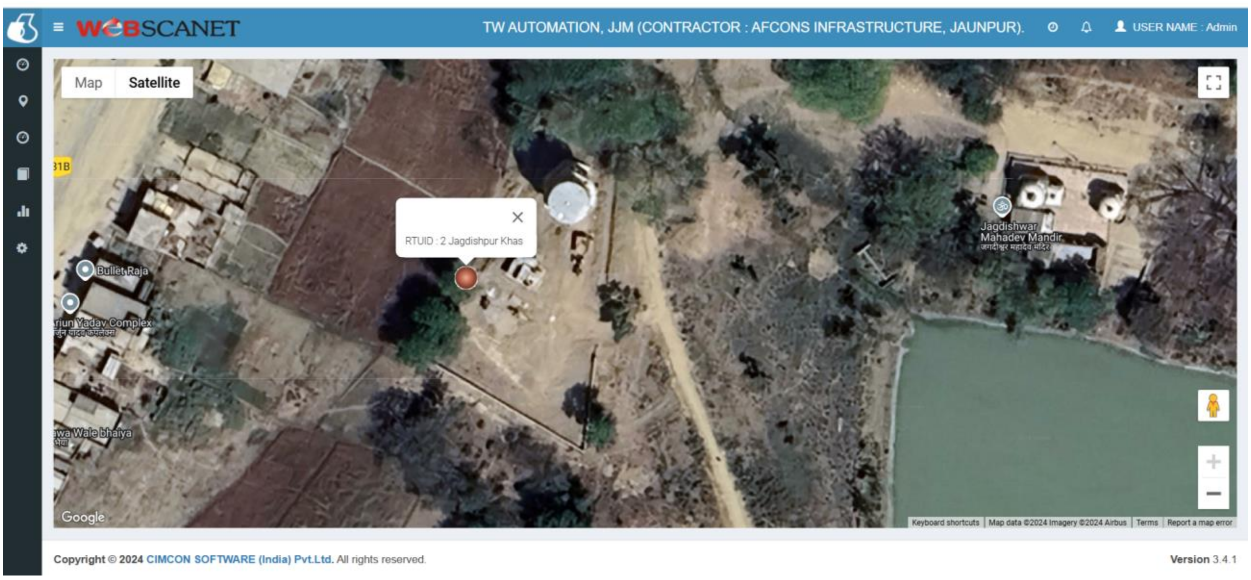

Fig.12 Scheme Location map on WebScanet.

Operation and control Philosophy of TW Automation System:

1. Operation of pumping plant: Pumps will receive feedback from Radar type level sensor installed at OHT and pump will start automatically if following conditions are met.

a. Water level at OHT is low.

b. Healthy energy source available(solar/DG/Grid).

c. Hydrostatic level sensor showing minimum submergence of pump.

d. Level of hypo chloride solution in chlorinating plant is OK.

2. Valve Operation: Three electrically operated valve will be installed, and each will operate as per feedback of different devices.

a. Bypass valve will be at normally open position at start of pump and turbidity analyzer will send signal to RTU once turbidity of water being pumped comes under permissible limit to close bypass valve and to open main line valve.

b. Main line valve will be at normally closed position. This valve will get opened once turbidity in water being pumped from tubewell comes under permissible limit. Flow meter will sense the flow coming out of pump and will send signal to RTU if there is over pumping observed to adjust opening/closing of main line valve.

3. Automatic Chlorinating System: TWs will be running at Solar power system and Discharge coming out of Tubewell depend upon generation of solar power at any particular time hence all dozing system should be compatible to adjust its dozing rate according flow rate coming out of tubewell. Dozer will communicate with RTU and Flow meter to sense flow coming out of pump and adjust its dozing rate as per desired dozing rate so that residual chlorine at outlet remains 0.2ppm. Dozer will communicate with RTU to stop the pump if level of hypo chloride solution reaches critically low level. Alarm will also be generated for critical level of HoCl in storage tank.

4. Radar Level Sensor: Radar level sensor installed at Over Head Tank will continuously monitor water level in overhead tank and will send data to RTU and RTU will trigger ON/OFF pump set.

5. Residue Chlorine Analyzer: Analyzer will be installed at outlet of Over Head Tank, and will continuously monitor residue chlorine level of water being supplied to house hold and the data will be communicated to RTU. RTU will sense this data and will adjust dozing rate if required.

6. Depth sensor: Depth sensor installed at inside the borewell with continuously. monitor depth of the water level inside borewell and will communicate following information to RTU. Static water level Running water level Alarm generation for critical water level. (if depression in water level is beyond permissible limit). All above operation will be monitored remotely at individual scheme as well as at Master Control Station.

Borewell Hydrostatic Levels details

The terms spring level, static level, and running level refer to the water levels and dynamics in a borewell. Here's an explanation of each term:

Spring Level: It indicates the presence of a water at borewell or aquifer and is critical for determining the borewell's yield potential.

Static Level: The static level is the depth of water in the borewell when the pump is turned off, and there is no water being extracted.
Static level is measured after the borewell has been idle for some time, allowing the water table to stabilize.

Running Level: The running level is the water level in the borewell when the pump is in operation and water is being drawn.

Drawdown: The difference between the static level and the running level is called drawdown, it depends on factors like:

a. Pumping rate

b. Borewell yield

VI. CONCLUSION

The analysis of the tubewell automation system for the Jagdishpur Khas Water Supply System using Webscanet software provides valuable insights into the efficiency, reliability, and overall performance of the water supply network. The implementation of webscanet software has enabled real-time monitoring and automation, resulting in improved operational management and optimized resource utilization.

Key takeaways from the analysis include:

Enhanced Efficiency: Automation has significantly reduced manual interventions, leading to better control over water distribution and minimizing energy wastage.

Real-Time Monitoring: The integration of webscanet software ensures accurate and timely data acquisition, aiding in proactive maintenance and fault detection.

Resource Optimization: Automated operations have helped in reducing water loss, improving water quality and ensuring required flow to filled OHT.

Sustainability: The system's automation aligns with sustainable practices by reducing energy consumption and optimizing resource use, which can serve as a model for similar projects in other regions.

The study highlights the critical role of advanced technology in modernizing water supply systems, ensuring their reliability and sustainability.

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