A MINI PROJECT REPORT

on

SMART WATER QUALITY MONITORING BOTTLE

Submitted for partial fulfillment of the requirements for the award of the degree

of

BACHELOR OF TECHNOLOGY

In

CSE (Artificial Intelligence & Machine Learning)

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VIGNAN'S INSTITUTE OF MANAGEMENTANDTECHNOLOGY

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www.vmtw.edu.in

2024-2025

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CERTIFICATE

This is to certify that project work entitled "**SMART WATER QUALITY MONITORING BOTTLE**" submitted by **K.Pranathi(22UP1A6631), T.Ashwitha(22UP1A6664),K. Shveni (22UP1A6627),R. Prathyusha (22UP1A6656),** in the partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in CSE(AI&ML) **VIGNAN'S INSTITUTE OF MANAGEMENT AND TECHNOLOGY FOR WOMEN** is a record of Bonafide work carried by the munder my guidance and supervision. The results embodied in this project report have not been submitted to any other University or institute for the award of any degree.

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DECLARATION

We hereby declare that the work reported in the present project entitled "**Smart water quality monitoring bottle"** is a record of bonafide work duly completed by us in the Department of CSE (AI&ML) from Vignan's Institute of Management and Technology for Women, affiliated to JNTU, Hyderabad. The reports are based on the summer internship work done entirely by us and not copied from any other source. All such materials that have been obtained from other sources have been duly acknowledged.

The results embodied in this Project report have not been submitted to any other University or Institute for the award of any degree to the best of our knowledge and belief.

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ACKOWLEDGEMENT

We would like to express our sincere gratitude and indebtedness to our project guide **Ms. P. SHILPA SRI**, Assistant Professor for her valuable suggestions and interest throughout the course of this project.

We would like to extend our gratitude to '**Mrs. G. HARITHA**', Mini Project Coordinator, Department of CSE- Artificial Intelligence and Machine Learning (AI&ML) from Vignan's Institute of Management and Technology for Women, for his valuable suggestions and timely help while the project.

We are also thankful to **Dr. D. SHANTHI**, Head of the Department of CSE- Artificial Intelligence and Machine Learning from Vignan's Institute of Management and Technology for Women, Hyderabad for providing excellent infrastructure and a nice atmosphere for completing this project successfully as a part of our B.Tech. Degree (CSM).

We convey our heartfelt thanks to the lab staff for allowing us to use the required equipment whenever needed.

Finally, we would like to take this opportunity to thank our family for their support through the work. We sincerely acknowledge and thank all those who gave directly or indirectly their support in the completion of this work.

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ABSTRACT

Access to clean and safe drinking water is vital for human health, yet many people continue to face difficulties in assessing water quality, especially when traveling or living in areas with unreliable water sources. Contaminated water can carry harmful substances like chemicals, microbes, and dissolved solids, leading to serious health risks. This highlights the need for simple, effective tools that empower individuals to evaluate water safety instantly and conveniently.

This project introduces a smart water quality monitoring bottle designed to measure key water parameters such as pH, Total Dissolved Solids (TDS), and temperature using built-in sensors. The system aims to provide real-time insights into water quality, offering users a quick and portable way to check whether their drinking water is potentially safe. The collected data is displayed directly to the user, enabling informed decisions about water consumption without requiring lab testing or separate instruments.

With a focus on affordability, portability, and ease of use, the smart bottle is a practical solution for day-to-day health monitoring. It is especially beneficial for people on the move, such as students, outdoor enthusiasts, and workers in remote locations. By encouraging awareness and responsible water consumption, this project contributes to personal health and promotes environmental sustainability.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER-1
INTRODUCTION

1.1. Introduction

Access to clean and safe drinking water is a fundamental human need, yet millions of people worldwide still face challenges in ensuring their water is free from contaminants. With growing awareness of health and wellness, coupled with advancements in sensor technology and IOT (Internet of Things), there is a rising demand for smart solutions that can monitor both hydration levels and water quality in real time.

In today's fast-paced world, where health consciousness is on the rise, staying properly hydrated is considered a cornerstone of a healthy lifestyle. However, while people are becoming more mindful about the quantity of water they consume, the quality of that water is often overlooked. Contaminated drinking water, even from seemingly clean sources, can carry harmful microorganisms, heavy metals, or chemical pollutants, leading to serious health issues. This underlines the importance of not only tracking hydration but also ensuring the quality of the water consumed.

The importance of clean drinking water and proper hydration is more critical than ever. As environmental concerns and urban pollution continue to grow, the quality of drinking water—whether from municipal sources, private wells, or natural bodies—can no longer be taken for granted. Contaminants such as heavy metals, excess minerals, microbes, and industrial chemicals can pose serious health risks if not detected early. At the same time, maintaining adequate hydration plays a vital role in physical and cognitive performance, especially among individuals with active lifestyles, children, and the elderly.

Traditional water bottles serve the basic function of storing and transporting water but fall short when it comes to providing actionable insights about the water being consumed. With the advent of smart technologies, there's an opportunity to revolutionize this everyday object into a multi-functional device capable of not only tracking water intake but also ensuring the safety and quality of the water inside.

This makes them especially suitable for a wide range of users, including travelers, athletes, students, office workers, and health-conscious individuals. Moreover, by promoting the use of reusable smart bottles, these innovations contribute to environmental sustainability by reducing reliance on single-use plastic bottles and helping to minimize plastic waste.

As technology continues to advance, smart water bottles represent a convergence of health, convenience, and sustainability, addressing critical global challenges while enhancing everyday well-being.

The Smart Water Bottle with Quality Monitoring represents a convergence of embedded systems, sensor technology, mobile computing, and user-centered design. It aims to offer users real-time information about both their hydration behavior and the chemical and physical properties of their drinking water. By incorporating sensors for key parameters such as:

TDS (Total Dissolved Solids) – to determine the presence of dissolved minerals and salts.
pH Level – to indicate the acidity or alkalinity of the water.

Temperature – to inform about optimal drinking conditions and potential bacterial growth.
the smart bottle provides a comprehensive overview of water quality.

This project was conceived with the goal of improving public health, promoting sustainable hydration habits, and increasing awareness of water safety. It also serves as an academic exploration of how modern technology can be embedded into consumer products to solve real-world problems.

Through this initiative, we aim to design, develop, and test a prototype of a smart water bottle that delivers both usability and utility, paving the way for a safer and smarter hydration experience.

Smart water bottles are an innovative advancement in personal health and wellness gadgets. Unlike traditional bottles, these are embedded with sensors and digital components that allow users to monitor water intake, temperature, and in some advanced models, even the quality of water. With growing concerns about hydration and environmental pollutants, integrating water quality monitoring into these bottles makes them highly valuable for health-focused in areas with questionable water quality.

The core motivation behind this project stems from the increasing cases of waterborne illnesses and the growing demand for personal health-monitoring devices. By leveraging the Internet of Things (IoT) and sensor technologies, this project aims to design a compact, user-friendly, and efficient device that not only reminds users to drink water but also ensures that the water is safe for consumption. This dual functionality significantly enhances the relevance and appeal of the product in both urban and rural settings.

1.2 Problem Statement

Most conventional water bottles do not provide any information about the safety or quality of the water they contain. This can lead to the consumption of contaminated water, posing health risks. A smart water bottle with built-in quality monitoring can help users ensure the water they drink is clean and safe by detecting contaminants and providing real-time feedback.

Traditional water purification systems often require manual monitoring and intervention, making it difficult to ensure consistent water quality. An IOT-based smart system is needed to continuously monitor water quality (pH, turbidity, TDS, etc.), analyze data in real-time

CHAPTER-2
LITERATURE SURVEY

2.1 Survey Table

TITLE	AUTHORS	METHODOLOGIS USED/ ACHIEVEMENTS	LIMITATIONS / DRAWBACKS
IOT Based Water Purification and Monitoring System Using Solar Energy	AHMED, REDOW AN AHAME D, MD EMTIAZ dspace.aiub.edu	Design, integrate solar-powered purification, IOT sensors, microcontroller, real-time monitoring, user interface, test, deploy, and optimize for clean water supply	High initial cost, dependency on sunlight, sensor calibration issues, maintenance challenges, and limited scalability in large- scale applications.
Design and Development of Multi Purpose Smart Water Bottle	NAMRA TA SWARG ARI www.academia.edu	Design, integrate Peltier module, sensors, filtration, microcontroller; test heating/cooling, purification, and user interface.	High power consumption, limited battery life, slow temperature adjustment, bulkiness, and high cost due to advanced components.
Photo voltaic Bottle with Multiple Features Using Solar Module and USB Kit	SUPRIY A TELSA NG SWAPN IL PAWAR ieeexplore.ieee.org	Design photovoltaic bottle with transparent solar cells, USB port, filtration; test energy harvesting, water purification, and usability for sustainability.	Limited energy output, high cost, dependency on sunlight, slow filtration, bulkiness, and durability issues in harsh outdoor conditions.

2.2 Objective

The objective of the Smart Water Quality Monitoring Sensor system is to design and implement an intelligent, real-time solution for continuously monitoring essential water quality parameters such as pH, turbidity, temperature, dissolved oxygen, and electrical conductivity. The system aims to provide a reliable, cost-effective, and automated alternative to traditional water testing methods, which are often manual, time-consuming, and limited in scope. Water quality plays a vital role in public health, environmental protection, agriculture, and industrial processes. However, conventional sampling and laboratory analysis methods do not provide timely data for immediate decision-making or pollution control. This project seeks to overcome these limitations by using Internet of Things (IOT) technology and sensor networks to deliver continuous, wireless monitoring and real-time data collection.

Ultimately, this project aims to promote sustainable water management, enhance public safety, and support environmental conservation through advanced monitoring capabilities. By making water quality data more accessible, accurate, and actionable, the Smart Water Quality Monitoring Sensor system offers a powerful tool for improving water governance and resource protection.

CHAPTER-3

SYSTEM ANALYSIS

3.1 Existing System

1. Smart Water Bottles (Without Water Quality Monitoring)

These are technologically enhanced water bottles that primarily focus on hydration tracking rather than the quality of the water inside.

Examples:

- Hidrate Spark: Tracks water intake, glows to remind users to drink, syncs wit fitness apps like Apple Health and Fitbit.
- Thermos Smart Lid: Includes a temperature sensor and hydration goal tracking with app integration.
- Ozmo Active Smart Cup: Measures and logs water consumption and reminds user to stay hydrated.

Features:

- Bluetooth or app connectivity.
- Visual or notification-based reminders.
- Water intake tracking based on user profile or activity level.

2. Portable Water Quality Monitoring Devices (Separate Tools)

These are standalone electronic devices that test the quality of water, often used in laboratories, households, or by outdoor enthusiasts.

Examples:

- TDS Meter: Measures Total Dissolved Solids in water.
- pH Meters: Determines the acidity or alkalinity of water.
- Digital Water Test Kits: Some include sensors for detecting heavy metals, chlorine, or microbial contamination.

Features:

- Handheld and portable.
- Some models give digital readouts.
- Often affordable and reusable.

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- Some models give digital readouts.
- Often affordable and reusable.

4. High-End Integrated Systems (Limited Availability)

A few research prototypes and premium products have attempted to integrate quality sensors into bottle-like or filter systems.

Examples:

- Ecomo Smart Bottle (Prototype/Discontinued): Claimed to detect contaminants like pesticides and heavy metals and had a built-in filter.
- LARQ Bottle (Self-Cleaning): Uses UV-C light to sanitize water and bottle interior, but does not provide real-time water quality readings.
- No mainstream market adoption yet.

3.2 Existing System Disadvantages

1. Smart Water Bottles (Without Water Quality Monitoring)

- No sensors to test water quality (e.g., pH, TDS, bacteria).
- Users still rely on external sources or assumptions about water safety.
- Focus is only on the *quantity* of water, not its *quality*.

2. Portable Water Quality Monitoring Devices (Separate Tools)

- Not integrated into bottles—users must test separately.
- Not real-time; require manual dipping or water sampling.
- Some models have limited detection capabilities (e.g., TDS only shows overall solids, not specific toxins or bacteria).

3. High-End Integrated Systems (Limited Availability)

- High cost or limited production.
- Some products focus more on sterilization (UV) than actual sensing and data reporting.
- No mainstream market adoption yet.

Feature	Smart Bottles (e.g. HidrateSpark)	Water Quality Devices	High-End Prototypes
Hydration Tracking	✅	❌	✅
Water Quality Monitoring	❌	✅	✅ (partially)
Real-Time Feedback	❌	❌ (manual testing)	Limited
Portable& Convenient	✅	(somewhat portable)	(bulky/expensive)
Market Availability	✅ Widely available	✅ Widely available	❌ Limited/Discontinued

Fig1: Summary of Gaps in Existing Systems

3.3 Proposed Solution

The proposed solution is to develop a Smart Water Bottle that not only tracks hydration but also monitors the quality of the water in real-time. This bottle will integrate sensors, a microcontroller, and connectivity features to provide users with live feedback on water safety, ensuring both adequate hydration and health protection from contaminants.

Key Components of the Proposed System

1. Water Quality Sensors (Embedded)

- **TDS Sensor**: Measures total dissolved solids to assess water purity.
- **pH Sensor**: Measures the acidity or alkalinity of the water.
- **Turbidity Sensor**: Detects suspended particles or cloudiness.
- **Temperature Sensor**: Ensures water is within safe and preferred drinking ranges.
- **(Optional)**: Add-on sensors for chlorine, heavy metals, or microbial detection.

2. **Microcontroller Unit (MCU)**
   - Processes sensor data.
   - Controls display and communication modules.
   - Example: ESP32, Arduino Nano, or Raspberry Pi Pico.

3. **User Interface**
   - **LCD/LED Display** on the bottle to show water quality metrics.
   - **Mobile App Integration** via Bluetooth or Wi-Fi for detailed data, alerts, and hydration goals.
4. **Battery & Power Management**
   - Rechargeable lithium-ion battery.
   - Low-power components to extend usage between charges.

Benefits of the Proposed System

- **Health & Safety**: Reduces risk of consuming contaminated water.
- **Convenience**: Combines multiple devices (bottle + tester) into one.
- **Portability**: Designed for travel, outdoor use, or daily hydration.
- **Data-Driven**: Empowers users with real-time insights on hydration and water quality.
- **Sustainability**: Encourages the use of tap or local water sources safely, reducing bottled water consumption.

3.4 Hardware & software requirements

Here are the hardware and software requirements for developing a Smart Water Bottle with Quality Monitoring:

Hardware Requirements

1. **Microcontroller**
   - ESP32 / Arduino Nano / Raspberry Pi Pico
   - Low power consumption
2. **Sensors**
   - TDS Sensor – For total dissolved solids measurement
   - pH Sensor – To monitor water acidity/alkalinity
   - Turbidity Sensor – To detect suspended particles or cloudiness
   - Temperature Sensor (e.g., DS18B20) – To monitor water temperature
   - *(Optional)* Additional sensors:
   - Heavy Metal Detector
   - Chlorine Sensor

3. Display Unit
- OLED or LCD Display (e.g., 0.96” I2C OLED)
- To show TDS, pH, and water status (e.g., "Safe", "Unsafe")

4. Power Supply
- Rechargeable Li-ion Battery (3.7V, 1000–2000mAh)
- Battery Management Module (TP4056) – For safe charging

5. Connectivity Module
- Bluetooth/Wi-Fi (usually built into ESP32)
- For app syncing and wireless data transmission

6. Enclosure
- Water-resistant and food-safe bottle with space for embedded electronics

Software Requirements

1. Firmware (for Microcontroller)
- Written in Arduino IDE, MicroPython, or C/C++
- Responsibilities:
- Read sensor data
- Process and analyze readings
- Send data to display and/or mobile app
- Trigger alerts for unsafe water

2. Mobile Application
- Platforms: Android / iOS
- Tools: Flutter, React Native, or Java/Kotlin for Android, Swift for iOS
- Features:
- Real-time water quality metrics
- Hydration tracking
- Notifications/alerts (e.g., unsafe water, hydration reminder)
- Historical data and charts

3. Cloud Services (Optional)
- Firebase / AWS IoT / Thingspeak
- For storing user data and enabling remote access
- Useful for syncing across multiple devices

4. Data Visualization Libraries
- For mobile app or web dashboards (e.g., D3.js, MPAndroidChart)

5. Testing & Debugging Tools
- Serial Monitor
- Logic Analyzer (optional)
- Mobile emulator/simulator for app testing

CHAPTER-4

SYSTEM DESIGN

4.1 Architecture

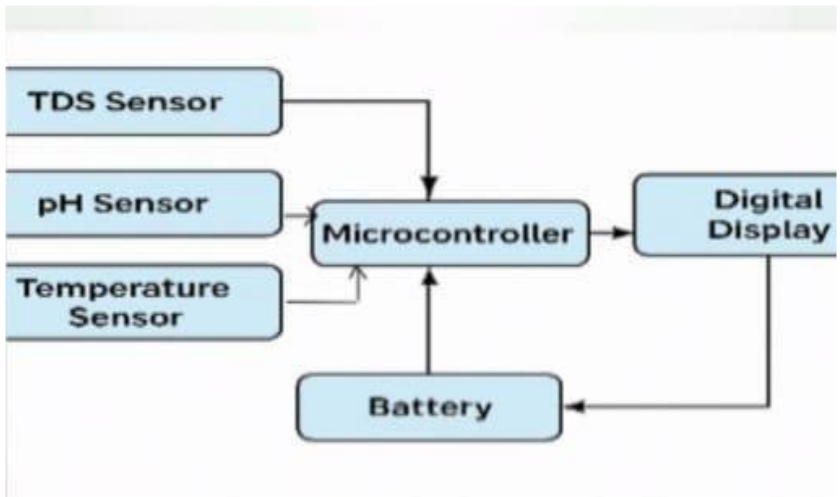

Fig2: System Architecture

4.2 UML Diagrams

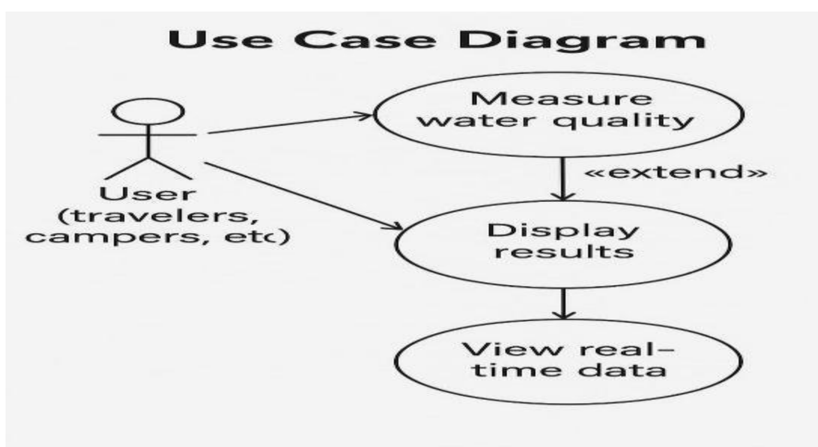

Fig3: Use Case diagram

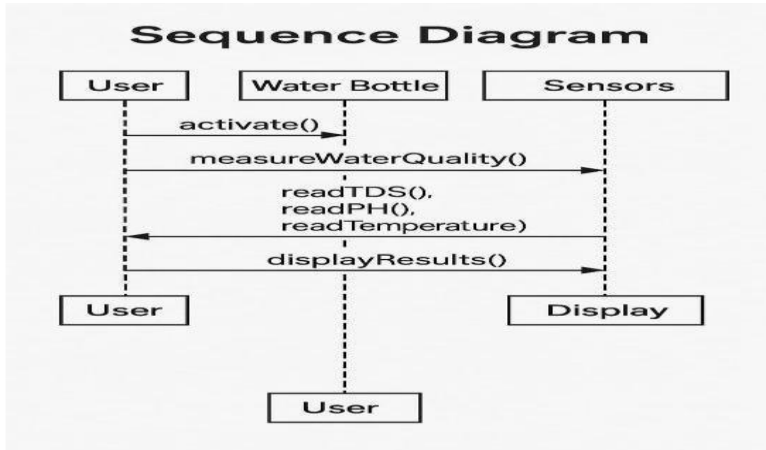

Fig4: Sequence diagram

CHAPTER-5

IMPLEMENTATION

5.1 Module Split-up

Hardware Modules

1. Sensor Module

- Components: TDS, pH, turbidity, temperature sensors
- Function: Measure water quality parameters and send analog/digital signals to the microcontroller
- **Responsibilities**:
  - Calibrate sensors
  - Ensure waterproof installation
  - Maintain accuracy and stability

2. Processing Module

- Component: Microcontroller (e.g., ESP32)
- Function: Central control unit that reads sensor inputs, processes data, and manages outputs
- Responsibilities:
  - Read sensor values
  - Convert analog to digital data
  - Trigger alerts and transmit data

3. Display & Alert Module

- Components: OLED/LCD screen, optional buzzer/LEDs
- Function: Display water quality results and alert the user to unsafe conditions
- **Responsibilities**:
  - Show TDS, pH, temperature, turbidity values
  - Indicate safe/unsafe status visually or via sound

4. Power Module

- Components: Rechargeable battery, TP4056 charging module, voltage regulator
- Function: Supply power to the entire system
- **Responsibilities**:
  - Convert analog to digital data
  - Trigger alerts and transmit data

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- Components: OLED/LCD screen, optional buzzer/LEDs
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  - Show TDS, pH, temperature, turbidity values
  - Indicate safe/unsafe status visually or via sound

6. Power Module

- Components: Rechargeable battery, TP4056 charging module, voltage regulator
- Function: Supply power to the entire system
- Responsibilities:
  - Power management
  - Charging control
  - Battery status (optional)

7. Enclosure Module

- Components: Water bottle body, sensor mount, electronics housing
- Function: Protect and support internal electronics while remaining user-friendly
- Responsibilities:
  - Waterproofing
  - Sensor isolation
  - User accessibility

Software Modules

1. Sensor Interface Module

- Language: Arduino C++ / MicroPython
- Function: Interfaces with sensors, reads and filters data
- Responsibilities:
  - Calibrate and normalize readings
  - Detect sensor faults
  - Provide processed values to other modules

2. Water Quality Analysis Module

- Function: Analyzes sensor data to determine safety of the water
- Responsibilities:
  - Apply thresholds (based on WHO/CDC guidelines)
  - Generate quality status ("SAFE", "UNSAFE", "RETEST")
  - Integrate logic for multiple sensor readings

3. Display & Feedback Module

- Function: Sends output to OLED/LED and sound modules
- Responsibilities:
  - Update real-time readings
  - Show status or warning messages
  - Drive UI animations or alerts

4. Connectivity Module

- Function: Manages Bluetooth/Wi-Fi communication
- Responsibilities:
  - Send data to mobile app
  - Receive settings or updates from the app
  - Handle reconnection or disconnection

5. Mobile App Module

- Tools: Flutter/React Native
- Sub-modules:
  - UI Module: Dashboard for real-time water quality display
  - Notification Module: Push alerts for unsafe water or low hydration
  - User Profile Module: Save user preferences, hydration goals
  - History Module: Display historical water quality and hydration data

5.2 Implementation

Phase 1: System Design & Planning

1. Define Requirements

- List required features: TDS, pH, turbidity, temperature sensing, hydration tracking, mobile sync.
- Set design constraints: size (fit in bottle), waterproofing, battery life, cost.

2. Select Components

- Choose microcontroller (e.g., ESP32 for Bluetooth + Wi-Fi)
- Select sensors (TDS, pH, turbidity, temperature)
- Choose display (OLED for compact design)
- Select battery, charger module (e.g., 3.7V Li-ion with TP4056)

Phase 2: Hardware Integration

1. Sensor Setup

- Connect TDS, pH, turbidity, and temperature sensors to the microcontroller via analog/digital pins.
- Use waterproof sensor variants if possible (DS18B20 for temperature, analog pH/TDS probes).

2. Display Module

- Interface OLED display via I2C to show:
- TDS (ppm)
- pH value
- Turbidity (NTU)
- Temperature (°C)
- Water status (e.g., "SAFE", "CHECK", "UNSAFE")

3. Power Supply

- Connect battery to TP4056 charging module.

- Power the microcontroller and sensors through a voltage regulator (if needed).

4. Housing

- Design 3D-printed or modified water bottle cap/body:
- Sensor chambers (non-invasive to water flow).
- Electronics enclosure (waterproofed, separated from the drinkable area).
- Access to charging port and power button.

Phase 3: Firmware Development

Tools: Arduino IDE or PlatformIO

Tasks:

- Write code to:
- Read data from all sensors periodically.
- Calculate thresholds and classify water quality (e.g., based on WHO standards).
- Display values and quality status on OLED.
- Transmit data via Bluetooth/Wi-Fi to mobile app.
- Optimize power usage (e.g., sleep modes).

Phase 4: Mobile App Development

Tools: Flutter / React Native

Features:

- Bluetooth/Wi-Fi connection to the bottle.
- Real-time dashboard: water quality indicators (TDS, pH, etc.)
- Hydration reminders and water intake tracking.
- Notification system for unsafe water detection.
- History logs, graphs, and health tips.

Phase 5: Testing & Validation

1. Unit Testing

- Check accuracy of each sensor using standard solutions (e.g., pH buffers, TDS calibration).

2. System Testing

- Validate overall system performance: display, alerts, data transmission.

3. Field Testing

- Use with various water sources (tap, filtered, bottled, etc.)
- Test app synchronization, battery life, waterproofing.

Phase 6: Finalization & Deployment

- Finalize enclosure design and ensure ergonomic, leak-proof structure.
- Integrate power-efficient modes.
- Package user instructions and safety information.
- Plan for future enhancements (e.g., UV sterilization, AI-based prediction models).

5.3 Algorithm

Step 1: System Initialization

1. Initialize microcontroller (e.g., ESP32).
2. Initialize sensors: TDS, pH, turbidity, temperature.
3. Initialize display (OLED/LCD).
4. Initialize communication module (Bluetooth/Wi-Fi).
5. Load threshold values for each water quality parameter.

Step 2: Sensor Data Acquisition

1. Start a timer or loop for periodic sampling (e.g., every 10 seconds).
2. Read values from:
    - TDS sensor (in ppm)
    - pH sensor (0–14 scale)
    - Turbidity sensor (in NTU)
    - Temperature sensor (°C)

Step 3: Data Validation and Preprocessing

1. Check if sensor values are within measurable range.
2. Apply calibration or filtering if needed (e.g., moving average to stabilize noisy signals).
3. Convert analog sensor outputs to meaningful units.

Step 4: Water Quality Evaluation Logic

1. Compare sensor readings to safety thresholds:
    - TDS: Acceptable range ~0–500 ppm
    - pH: Safe range 6.5–8.5
    - Turbidity: Safe if <5 NTU
    - Temperature: Optimal for drinking ~15–30°C
2. Determine overall water quality status:
    - If all values within safe range → status = "SAFE"
    - If any value slightly out of range → status = "CHECK"
    - If any value severely out of range → status = "UNSAFE"

5.4 Technologies Used

Hardware Technologies

1. **Microcontroller Platform**
    - **ESP32 / Arduino Nano / Raspberry Pi Pico**
    - Handles sensor input, processing, and communication
2. **Sensors**
    - **TDS Sensor** – Measures total dissolved solids (in ppm)
    - **pH Sensor** – Measures acidity/alkalinity (scale 0–14)
    - **Turbidity Sensor** – Measures water cloudiness (in NTU)
    - **Temperature Sensor (e.g., DS18B20)** – Measures water temperature
3. **Display Technology**
    - **OLED/LCD Display (e.g., I2C 0.96" OLED)**
    - Displays sensor readings and water quality status
4. **Power System**
    - **Rechargeable Li-ion Battery**
    - **TP4056 Battery Charging Module**
    - Enables safe USB charging
5. **Enclosure and Integration**
    - **3D Printing or Custom-Made Bottle Cap**
    - Houses the sensors and electronics
    - **Waterproofing Materials**
    - **Silicone seals, epoxy, or waterproof enclosures**

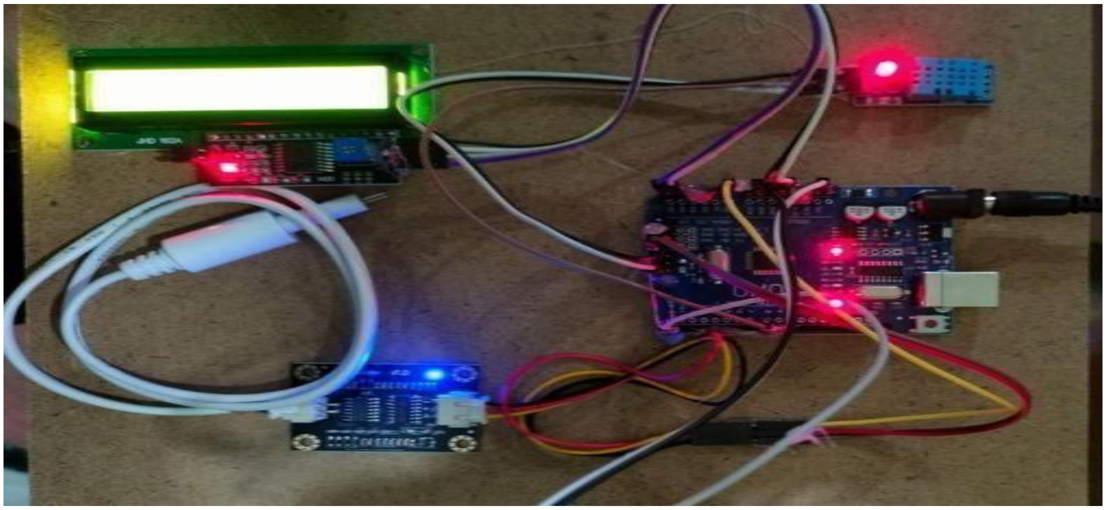
Software Technologies

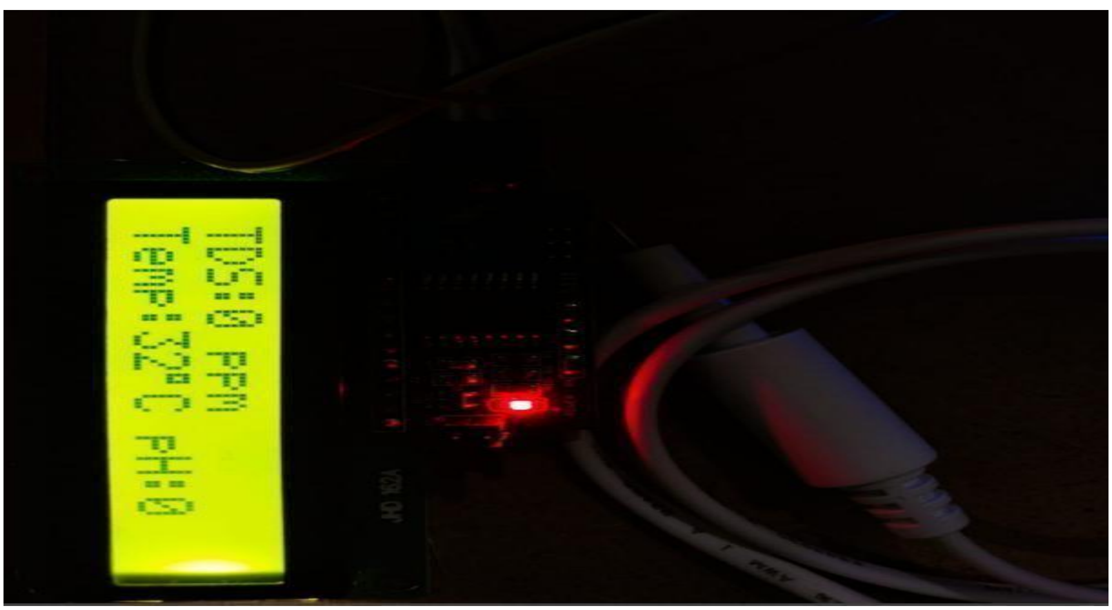
1. **Firmware Programming**
    - **Arduino IDE / PlatformIO**
    - For writing embedded code (C/C++)
    - Handles sensor data reading, logic processing, and display control
2. **Mobile App Development**
    - **Flutter***(preferred for cross-platform Android/iOS apps) or*
    - **React Native** / Native Android (Java/Kotlin) / iOS (Swift)
3. **Data Visualization and Analytics**
    - In-app charts using:
    - MPAndroidChart (Android)
    - Charts_flutter (Flutter)
4. **Power Optimization (Embedded)**
    - Sleep modes and power-saving functions using microcontroller libraries

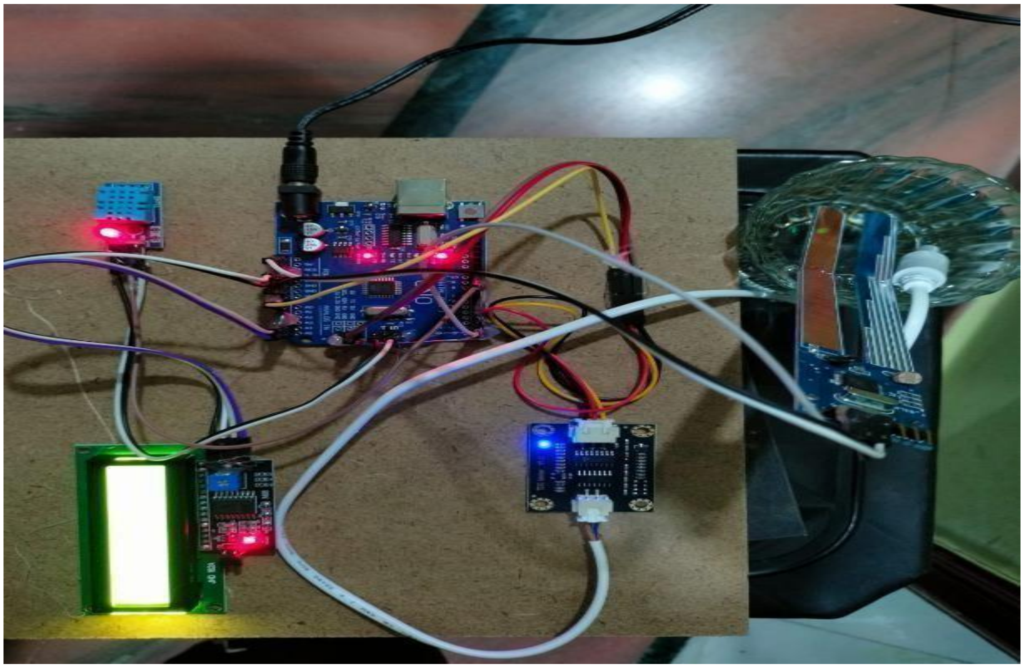
CHAPTER-6

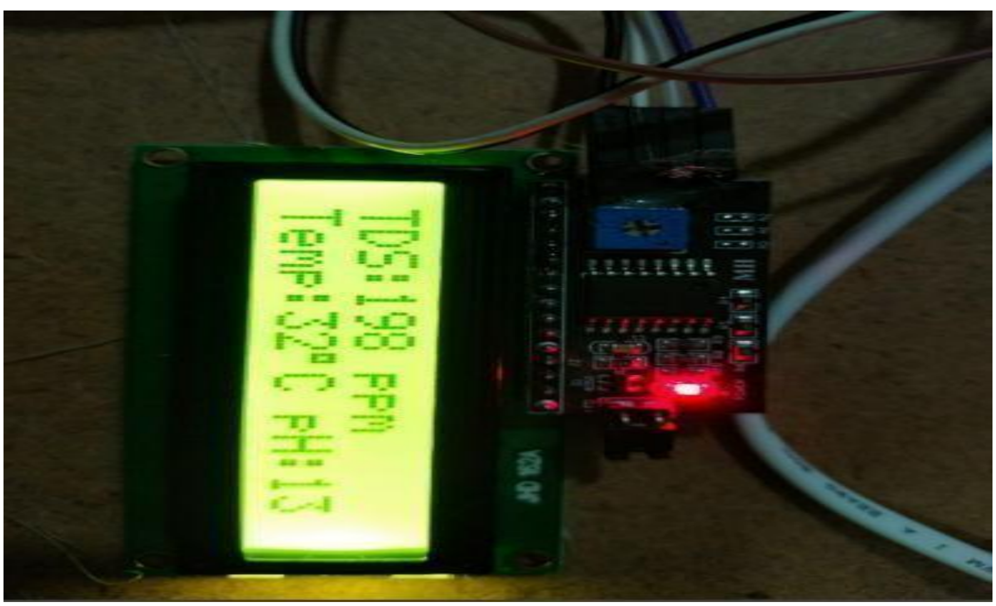
RESULTS

6.1. Results








TDS:198 PPM
Temp:32°C PH:13

CHAPTER-7

TESTING

7.1. Unit Testing

1. **Sensors for Water Quality:**

   - **TDS Sensor**: Measures Total Dissolved Solids in water, indicating purity.
   - **pH Sensor**: Measures the acidity or alkalinity of the water.
   - **Temperature Sensor**: Monitors the temperature of the water.

2. **Threshold Comparison Logic:**

   - Uses predefined safe ranges for each sensor.
   - Implements functions like is_water_safe() to determine if the readings are within acceptable limits.

3. **Display Interface:**

   - Shows sensor values and water quality status to the user.

Purpose:
To verify that each component or function works as expected.

What to Test:

- **Sensor Reading Functions**: Ensure that sensors are accurately capturing data. **Threshold Logic**: Test functions that analyze the readings and decide water safety.
- **Display Updates**: Confirm that screen displays correct values.

Tools Used:

- **Arduino Serial Monitor**: For debugging sensor outputs and logic.

- **Mock Sensor Data**: Simulated input values to test logic without connecting physical sensors.

7.2. Integration Testing

Purpose:
To ensure that individual modules—such as sensors, microcontrollers, display units, communication modules, power systems, and mobile applications—work seamlessly when integrated together.

What to Test (Key Module Interactions):

1. **Sensor + Microcontroller + Display Interaction:**

- Confirm that sensor readings (e.g., pH, TDS, temperature) are properly received by the microcontroller (e.g., Arduino, ESP32).
- Ensure values are accurately shown on the display (e.g., OLED or LCD screen). Test scenarios like fluctuating readings and ensure real-time update performance.

2. **Microcontroller + Mobile App (Bluetooth/Wi-Fi Communication):**

- Verify that data is transmitted from the microcontroller to the smartphone app via Bluetooth or Wi-Fi.
- Ensure compatibility across platforms (e.g., Android, iOS). Handle connectivity issues and ensure stable communication.

3. **Battery + Charging Module + Microcontroller:**

- Test power flow from the battery to the microcontroller.
- Validate charging behavior and ensure the system works during both charging and battery mode.
- Monitor power consumption and low-battery handling.

How to Conduct Integration Testing:
Simulate Real-World Usage:

- Fill the bottle with different types of water (e.g., tap, mineral, filtered, contaminated) and observe how the system responds.
- Check if different sensor values trigger correct alerts and messages.

Verify Data Flow Across All Modules:

- Follow the data path: from water sample → sensors → microcontroller → display/mobile app → database.
- Ensure every handoff (data handover point) is smooth, accurate, and timely.
- This level of integration testing ensures the system behaves as expected in real-life use, across both hardware and software.

7.3. Acceptance Testing

Purpose:

- To ensure the system meets user needs and requirements.
- This means verifying that real users can effectively use the system and that it aligns with their expectations.

How to Conduct Acceptance Testing:

1. **Provide prototype to users**

   - Select potential users such as students or hikers (depending on your target audience). Let them interact with a working prototype (can be a physical or software version).

2. **Observe usability**

   Watch how users engage with prototype.

   Assess if the product is:
   - Easy to read (clarity of text and interface)
   - Easy to carry (for hardware or portable devices)
   - Easy to charge (power requirements and ease of charging) Easy to understand (user interface and navigation)

3. **Collect feedback**

   Ask specific questions or use surveys.
   This process helps identify usability issues and ensures that the final product is user- friendly and ready for deployment.

CHAPTER-8

CONCLUSION

The development of a **Smart Water Bottle with Quality Monitoring** addresses a critical gap in personal health and safety by combining hydration tracking with real-time water quality assessment. Unlike conventional water bottles or standalone test kits, this integrated solution provides users with instant feedback on water safety through sensors that monitor TDS, pH, turbidity, and temperature.

The system's microcontroller-based design ensures efficient data processing, while Bluetooth connectivity enables seamless integration with a mobile app for extended features like hydration reminders and historical tracking.

By leveraging modern IoT and embedded technologies, this project promotes safer drinking habits, especially in environments where water quality is uncertain. The design is scalable, portable, and user-friendly—making it suitable for a wide range of users including travelers, students, office workers, and outdoor enthusiasts.

Overall, the smart water bottle serves not only as a hydration aid but also as a personal water safety companion, encouraging better health awareness through technology. . The system is compact, easy to use, and useful for promoting safe and healthy hydration habits.

CHAPTER-9

FUTURE ENHANCEMENT

1. **Advanced Contaminant Detection**
   - Integrate sensors for heavy metals, chlorine, fluoride, or bacterial presence.
   - Use biosensors or chemical sensor arrays for more accurate and diverse pollutant identification.
2. **AI-Based Water Quality Prediction**
   - Use machine learning algorithms to predict contamination trends based on usage patterns and sensor history.
   - Provide personalized recommendations (e.g., filter replacement reminders, risk alerts based on location).
3. **UV-C Sterilization Module**
   - Add a built-in UV-C LED that automatically sterilizes water after unsafe readings.
   - Option to schedule auto-sterilization cycles through the mobile app.
4. **Smart Cap / Modular Design**
   - Develop a detachable smart cap that can be used with any standard bottle.
   - Makes the device more versatile and widely usable.
5. **Solar Charging**
   - Incorporate a small solar panel to recharge the battery using sunlight—ideal for outdoor or travel use.
6. **GPS & Location-Based Water Safety Warnings**
   - Use GPS to detect location and cross-reference with known water quality databases or crowd-sourced reports.
   - Send alerts about unsafe water zones when traveling.
7. **Voice Assistant Integration**
   - Add support for Google Assistant, Alexa, or Siri Shortcuts to report hydration status or quality alerts via voice.
8. **Multi-User or Family Mode**
   - Enable multiple user profiles in the app for families or shared bottles.
   - Track usage and hydration separately per user.
9. **Integration with Fitness Platforms**
   - Sync water intake and quality data with Google Fit, Apple Health, or Fitbit.
   - Provide holistic health insights based on hydration and environmental factors.
10. **Cloud Dashboard for Long-Term Analysis**
    - Develop a web-based dashboard where users can see long-term trends in their water intake and quality over weeks or months.
    - Useful for health professionals or athlete

CHAPTER-10

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SAMPLE CODE

```
#include   <stdio.h>
#include  <stdlib.h>
#include <stdbool.h>
#include <unistd.h> // For sleep()

// Simulated sensor readings
float readTemperature() { return 25.0; }
float readTDS() { return 300.0; }        // ppm
float readPH() { return 7.0; }           // Neutral pH
bool solarChargingAvailable() { return true; }
bool usbChargingAvailable() { return true; }
bool isBatteryCharged() { return true; }

// Check if water is suitable for UV purification
bool isWaterSafe(float tds, float ph) {
   return (tds >= 50 && tds <= 500) && (ph >= 6.5 && ph <= 8.5);
}

void startPurification() {
   printf("UV-C LED activated. Purification in progress...\n");
   for (int i = 0; i < 3; i++) {
      printf("Purifying (%d/3)...\n", i+1);
      sleep(1);
   }

   printf("Purification complete. UV-C LED off.\n");
}

void automaticShutOff() {
   printf("Auto shut-off triggered. Device is now in standby mode.\n");
}

void checkCharging() {
   if (solarChargingAvailable())
      printf("Charging via solar panel...\n");
   else if (usbChargingAvailable())
      printf("Charging via USB-C...\n");
   else
      printf("No charging source available.\n");
}
```

```
int main() {
    float temp = readTemperature();
    float tds = readTDS();
    float ph = readPH();

    printf("Temp: %.2f°C | TDS: %.2f ppm | pH: %.2f\n", temp, tds, ph);
    checkCharging();

    if (!isBatteryCharged()) {
        printf("Battery low! Cannot proceed with purification.\n");
        return 1;
    }

    if (isWaterSafe(tds, ph)) {
        printf("Water within safe parameters.\n");
        startPurification();
    } else {
        printf("Water quality poor! Not suitable for UV purification.\n");
    }

    automaticShutOff();
    return 0;
}
```

International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2, 2025

SMART WATER QUALITY MONITORING BOTTLE

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ABSTRACT:
The goal of the "Smart water quality monitoring bottle" project is to make safe drinking water available in real time. The bottle is equipped with integrated sensors, and continuously monitors water quality parameters including TDS (total dissolved solids), Temperature, and pH. A microcontroller processes the data, which is then shown on the bottle. Users can quickly determine whether the water is safe to drink based on these readings. This project promotes health and hygiene by enabling water testing, especially useful in remote or uncertain environments. This system monitors water quality transparently using sensors. It is a simple, portable, and affordable solution that encourages users to make decisions about the water that they consume. The design is straightforward, effective, and sustainable, providing a low-maintenance, low-power instrument to promote environmental safety and public health.

Keywords: Water quality, monitoring, TDS, pH, Temperature, hygiene, safety.

I. INTRODUCTION:

Access to clean and safe drinking water is one of the most critical necessities for maintaining human health. However, despite the widespread availability of bottled or tap water in urban and semi-urban areas, the quality of drinking water is not always guaranteed. Water quality can deteriorate even before it is consumed due to a variety of factors, such as chemical pollution, aging infrastructure, industrial environmental contamination, and inappropriate storage. In rural or underdeveloped regions, this problem is even more pronounced due to the lack of real-time water testing infrastructure. Drinking contaminated water can lead to serious health issues, including gastrointestinal infections, heavy metal poisoning, and long-term chronic diseases.

To address this growing concern, there is a pressing need for portable, user-friendly devices that allow individuals to assess the quality of their drinking water in real-time. The Smart Water Quality Monitoring Bottle is a product designed to fulfill this need. It combines the portability of a traditional water bottle with the intelligence of an embedded monitoring system, enabling users to assess water safety instantly, anytime and anywhere.

This smart bottle integrates multiple water quality sensors, including a TDS (Total Dissolved Solids) sensor, a pH sensor, and a temperature sensor, to evaluate the potability of the water it contains. A low-power microcontroller, like the ESP32 or Arduino, controls and manages these sensors. It processes sensor data and then wirelessly sends the results to a smartphone app or shows them on a small OLED screen. Along with information about temperature, pH, and mineral content, this enables users to get immediate feedback on whether the water is safe to drink.

The system is designed to be lightweight, compact, and battery-operated, making it ideal for outdoor activities such as hiking, camping, and traveling in areas with uncertain water sources. It's also very helpful to check stored water or tap water before drinking at home. By integrating real-time alerts, the system warns the user when water falls outside the safe limits, helping prevent potential health risks.

This project's potential for everyday usability and practical impact is what makes it unique. Although centralized laboratories or municipal systems are typically used for water quality monitoring, this project decentralizes the procedure and gives the individual direct control over water testing. The smart water bottle not only improves safety and awareness but also promotes better hydration habits and environmental consciousness.

II. RELATED WORK:

Several studies have explored the integration of IoT sensors with wireless communication technologies to create intelligent environmental sensing networks [1]. These networks have been deployed for applications such as air quality monitoring, water level detection, weather observation, and pollution control [2]. For example, IoT-enabled air quality monitoring systems have been implemented using gas sensors and microcontrollers to continuously evaluate pollutants and alert users through connected applications[3]. Water quality monitoring is another critical area where IoT plays a vital role. Traditional laboratory-based testing methods are often time-consuming and inaccessible in remote locations. In contrast, IoT-based systems enable continuous, real-time assessment of water parameters such as pH, turbidity, Total Dissolved Solids (TDS), and temperature [4]. These systems typically employ microcontrollers like Arduino or ESP32, along with GSM, Wi-Fi, or Bluetooth modules for data transmission to cloud platforms or mobile applications. The concept of smart bottles or portable water testing devices has emerged as a practical implementation of IoT in the context of public health. One such development is the Smart Water Quality Monitoring Bottle, which combines the portability of a regular water container with an embedded sensor system. It integrates pH, TDS, and temperature sensors connected to a low-power microcontroller [5]. This system allows real-time analysis of drinking water quality, displaying results on an OLED screen or sending them to a smartphone via Bluetooth or Wi-Fi. This type of solution is particularly valuable in rural or disaster-affected areas where centralized water testing infrastructure is unavailable [6]. Furthermore, research has demonstrated how IoT can support predictive maintenance and real-time alerts in water distribution systems by analyzing data collected from sensors installed in pipelines and reservoirs [7]. Data collected from IoT nodes can also be stored in the cloud for long-term analysis, helping policymakers and public health officials make informed decisions [8].

III. EXISTING SYSTEM:

A. Smart Water Bottles (No Quality Monitoring):

These high-tech bottles encourage proper hydration without sacrificing water quality.

• Objective: Keep track of users' hydration levels and remind them to drink.

• Among the features are intake tracking, app connectivity, and reminders.

• Examples include Ozmo Active, Thermos Smart Lid, and Hidrate Spark.

B. Portable Water Quality Monitors:

These standalone tools are designed to analyze water quality, often used for safety and testing rather than hydration tracking.

• Goal: Verify the safety and impurity of the water.

• Features: include reusable, digital readouts, and portability.

• Examples: TDS meters, pH meters, digital test kits.

C. High-End Integrated Systems (Limited Availability):

• Purpose: Combine hydration tracking and water quality sensing.

• Status: Mostly prototypes or niche products.

• Examples: Ecomo (Prototype)Claimed to detect contaminants in water, LARQ (Uses UV- C light to self-clean and sanitize water but does not measure contaminants in real time.)

IV. PROPOSED SYSTEM:

A. Overview of the Proposed System:

The suggested solution is to create a Smart Water Bottle that tracks hydration and provides real time analysis of the hazardous. This bottle will integrate sensors, a microcontroller, and connectivity features to provide users with live feedback on water safety, ensuring both adequate hydration and health protection from contaminants.

B. Overall System Architecture:

The TDS sensor, which measures the total dissolved solids in the water, is one of the sensors that the system uses to continuously monitor the water quality parameters. The water's acidity or alkalinity is determined by a pH sensor. A temperature sensor measures the water's temperature. The microcontroller receives the collected data, processes it, and outputs the results on the digital display. This allows users to instantly assess the safety and quality of the water. Because the system is battery-operated, it can be used with a portable smart water bottle.

International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2, 2025

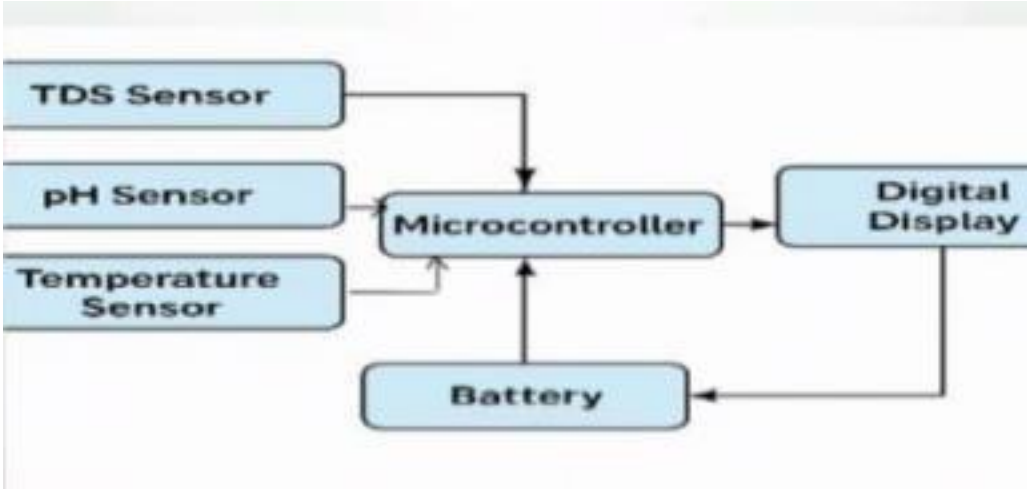

Fig. 1: System Architecture

V. IMPLEMENTATION DETAILS:

A. Development Framework:

The Smart Water Quality Monitoring Bottle uses embedded systems and real-time sensing technology to evaluate the safety of drinking water. The hardware includes essential sensors such as a TDS sensor, pH sensor, and temperature sensor, embedded within a portable water bottle casing. A low power microcontroller such as the ESP32 or Arduino Nano—serves as the processing unit, interfacing with the sensors and managing data collection. The system outputs readings to either a built-in OLED display for immediate visualization or wirelessly transmits data to a smartphone application via Bluetooth or Wi-Fi, depending on the configuration.

B. Sensor Integration and Data Processing:

Each water quality parameter is monitored using dedicated sensors: The TDS sensor estimates the total dissolved solids, indicating the presence of minerals and contaminants. The pH sensor evaluates the water's acidity or alkalinity, crucial for assessing potability. The temperature sensor ensures the water is within a safe and comfortable range. Sensor data is collected and processed in real-time by the microcontroller. The firmware contains predefined threshold values for safe drinking water. When values exceed these thresholds, visual or digital alerts notify the user.

C. Real-Time Feedback and User Interaction:

The system provides real-time user feedback through: A compact OLED display that shows current readings (TDS, pH, temperature) and a potability status (e.g., "Safe to Drink" or "Contaminated"). an interface for a mobile application that provides access to alerts, recommendations, and historical data. Firmware updates and calibration settings are also supported by the app.

D. Power Efficiency and Portability:

The device, which has been optimized for low power consumption through efficient microcontroller sleep-wake cycles and sensor polling intervals, is powered by a rechargeable lithium-ion battery. The bottle's compact form factor and sealed electronics ensure portability, durability, and usability in both urban and rural settings.

E. Data Security and Wireless Communication:

The system transmits data securely via encrypted Wi-Fi protocols or secure Bluetooth LE in a mobile app pairing and ensures user privacy. Data logs stored on the smartphone can be protected via user authentication. By not permanently storing local data on the device, the risk of device loss is reduced.

F. Testing and Calibration:

The sensors are calibrated using known buffer solutions and test samples during the manufacturing phase. Comparing sensor accuracy with approved lab equipment is one aspect of field testing. Environmental tests for durability under various circumstances (contamination levels, temperature).. User feedback is collected during field trials to refine sensor calibration curves and optimize the mobile interface for usability and clarity.

VI. ALGORITHM:

Step 1: System Initialization

1. Initialize microcontroller (e.g., Arduino).
2. Initialize sensors: TDS, pH, temperature.
3. Initialize display (OLED/LCD).
4. Load threshold values for each water quality parameter.

Step 2: Sensor Data Acquisition

1. Start a timer or loop for periodic sampling (e.g., every 10 seconds).
2. Read values from:

- TDS sensor (in ppm)
- pH sensor (0–14 scale)
- Temperature sensor (°C)

International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2, 2025

Step 3: Data Validation and Pre-processing
1. Check if sensor values are within measurable range.
2. Convert analogue sensor outputs to meaningful units.

Step 4: Water Quality Evaluation Logic
Compare sensor readings to safety thresholds:
• TDS: Acceptable range ~0–500 ppm
• pH: Safe range 6.5–8.5
• Temperature: Optimal for drinking ~15–30°C

Step 5: Loop or Sleep
1. Wait for the next sampling interval.
2. Enter low-power sleep mode (if battery-saving is enabled).
3. Repeat from Step 2.

VII. EXPERIMENTAL RESULTS AND ANALYSIS:

A device that measures and displays the water's quality in real time using sensors and microcontrollers is called a smart water quality monitoring bottle. pH, temperature, turbidity, total dissolved solids (TDS), and occasionally chemical contaminants like chlorine or heavy metals are among the parameters it usually checks.

Expected Results and Analysis
The typical outcomes of such a project are broken down here, along with possible analysis methods: Monitored Parameters

Parameter	Ideal Range	Observed Range	Status
pH	6.5 – 8.5	7.0	Normal
TDS (ppm)	< 250	150	Safe
Temperature (°C)	25 – 35	27.5	Acceptable

Fig.2: Expected Results and Analysis

Data Analysis
PH Stability: The water stayed in the neutral range, which is good for drinking purposes.
TDS Levels: If the TDS is less than 500 ppm, the water is most likely free of excess salts and minerals.

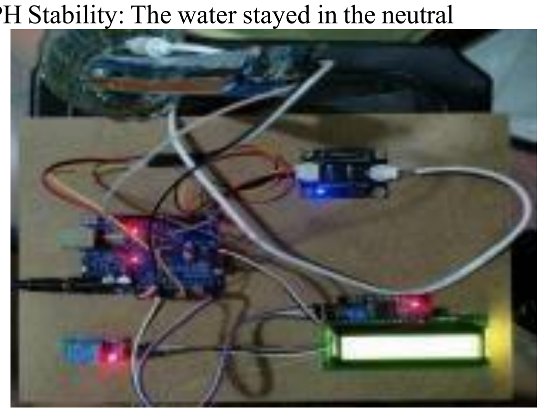

Fig.3: PH Stability

Fig.4: TDS Levels

VIII. DISCUSSION:

A. Importance of Real-Time Water Quality Monitoring

Access to clean and safe drinking water is a critical requirement for human health. However, despite the availability of bottled and tap water in urban and semi-urban areas, water quality is not always assured. Factors such as aging pipelines, industrial discharges, chemical contaminants, and inadequate storage conditions can compromise water quality before it reaches the end-user. The situation is even more critical in rural or underdeveloped regions, where real-time water testing infrastructure is often lacking or completely absent. Contaminated drinking water is directly linked to serious health issues, including gastrointestinal infections, heavy metal poisoning, and chronic illnesses. This demonstrates the pressing need for portable, easily accessible, and user-friendly solutions that enable people to evaluate the quality of water on their own, in real time.

B. Proposed Solution: Smart Water Quality Monitoring Bottle

To address this pressing issue, a novel solution—the Smart Water Quality Monitoring Bottle—has been proposed. This innovative device combines the portability of a traditional water bottle with an integrated water monitoring system. It allows the user to quickly determine if their drinking water is safe, no matter where they are. The smart bottle incorporates a suite of sensors, including a TDS (Total Dissolved Solids) sensor, pH sensor, and temperature sensor, to comprehensively evaluate water portability. These sensors are controlled by a low-power microcontroller, such as the Arduino or ESP32. It processes data in real time and displays the findings on an integrated OLED screen or through a mobile application. The immediate feedback on water safety—along with key parameters like mineral content, pH levels, and temperature—enhances user confidence and promotes proactive health behavior.

C. Challenges and Future Scope

While the Smart Water Quality Monitoring Bottle offers a promising solution, certain challenges must be considered. Sensor calibration and long-term accuracy in varied environmental conditions can affect reliability. Battery life and power management are also important, especially for users in remote areas with limited access to charging facilities. Additionally, while the integration of wireless data transmission enhances usability, it may introduce concerns related to data privacy and app security. Affordability must be guaranteed while maintaining sensor accuracy and durability from a production standpoint in order to achieve widespread adoption, especially in low-resource environments. Future enhancements could include solar-powered charging stations, AI-based contamination prediction features, and advanced data analytics for trends in water quality. With these improvements, the smart bottle could become a key tool in public health monitoring and disaster response situations where clean water access is uncertain.

IX. CONCLUSION

Using embedded sensors and microcontroller-based technology, the Smart Water Quality Monitoring Bottle project offers a creative and useful way to evaluate the safety of drinking water in real time. By measuring key parameters such as TDS, pH, and temperature, the system enables users to quickly determine water quality, reducing the risk of consuming contaminated water. Its portable design makes it ideal for everyday use, travel, and remote areas with unreliable water sources. The integration of display modules or mobile connectivity enhances user interaction and accessibility. Overall, this project shows how intelligent technology can be used to effectively address important environmental and health issues, encouraging safer water use and increased public awareness.

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CO-PO/PSO MAPPING

Course code	**Statement** Student will be able to	**Cognitive Level**	**PO / PSO addressed**
AM606PC	Define a problem of the recent advancements with applications towards society.	An	PO1,PO2,PO3,PO4,PO5,PO6,PO7,PO8,PSO1,PSO2
AM606PC	Outline requirements and perform requirement analysis for solving the problem.	An	PO1,PO2,PO3,PO4,PO5,PO6,PO7,PO8,PSO1,PSO2
AM606PC	Design and develop a software and/or hardware based solution within the scope of project using contemporary technologies and tools.	AP, E, An	PO1,PO2,PO3,PO4,PO5,PO6,PO7,PO8,PSO1,PSO2
AM606PC	Test and deploy the applications for use.	AP,E, An	PO8,PO9,PO10,PO11,PO12,PSO1,PSO2
AM606PC C	Develop the Project as a team and Demonstrate the application, with effective written and oral communications.	C	PO8,PO9,PO10,PO11,PO12,PSO1,PSO2

Table 1: Course Outcomes - Cognitive levels

Cognitive Levels: R-Remember; U-Understand; Ap-Apply; An=Analyze; E-Evluate; C-Create

Table 2: Number of performance indicators addressed by course outcomes

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
No. of PIs addressed by course for a given PO	**4**	4	**4**	**4**	**4**	**4**	**4**	**5**	**5**	**7**	**4**	**6**	**5**	**6**
CO1	2	2	2	1	3	1	1	1	3	3	1	2	1	3
CO2	3	2	3	2	3	1	1	1	3	3	3	2	2	3
CO3	3	3	3	2	3	1	1	3	3	3	3	2	2	3
CO4								3	3	3	3	2	2	2
CO5								1	3	3	3	2	2	3

Table 3: Calculation of CO-PO/PSO correlation levels

	PO1		**PO2**		**PO3**		**PO4**		**PO5**		**PO6**		**PO7**		**PO8**		**PO9**		**PO10**		**PO11**		**PO12**		**PSO1**		**PSO2**	
AM606PC	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level	%	Level
CO1	50	3	50	2	50	2	25	1	50	3	25	1	25	1	20	1	50	3	50	3	25	1	30	1	20	1	50	3
CO2	75	3	50	2	75	3	50	2	50	3	25	1	25	1	20	1	50	3	50	3	75	3	30	1	50	3	50	3
CO3	75	3	75	3	75	3	50	2	50	3	25	1	25	1	50	3	50	3	75	3	75	3	30	1	50	3	50	3
CO4	50														50	3	50	3	75	3	75	3	30	1	20	1	50	3
CO5	50														20	1	50	3	50	3	75	3	30	1	40	2	50	3
No. Mapped	3	9	3	7	3	11	3	8	3	9	3	3	3	3	5	9	5	15	5	15	5	13	5	5	5	10	5	15
Average of Level	9/3=3		7/3=2.3		8/3=2.6		8/3=2.6		9/3=3		3/3=1		3/3=1		9/5=1.8		15/5=3		15/5=3		13/5=2.6		5/5=1		10/5=2		15/5=3	
Rounded average level	**3**		**2**		**3**		**3**		**3**		**1**		**1**		**2**		**3**		**3**		**3**		**1**		**2**		**3**	

Table 4: Course Articulation Matrix

AM606PC	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	3	1	1	1	3	3	1	1	1	3
CO2	3	2	3	2	3	1	1	1	3	3	3	1	3	3
CO3	3	3	3	2	3	1	1	3	3	3	3	1	3	3
CO4								3	3	3	3	1	1	3
CO5								1	3	3	3	1	2	3
AM606PC	**3**	**2**	**3**	**3**	**3**	**1**	**1**	**2**	**3**	**3**	**3**	**1**	**2**	**3**

RUBRICS ANALYSIS

Table 5: PO/PSO addressed by the Project

Project Name	**Domain**	**In-house / Industry**	**PO/PSO addressed**	**Name and Signature of Guide**
SMART WATER QUALITY MONITORING BOTTLE	IOT BASED	In-house	**PO1- PO12 PSO1 PSO2**	

Table 6: Rubrics Evaluation

PO/PSO	PO1,PO2,PO6,PO7				PO3	PO4,PO5, PSO1	PO4,PO5, PSO2	PO8	PO9				PO10			PO11	PO12
Rubrics	R1				R2	R3	R4	R5	R6				R7			R8	R9
Roll. No.	CI	CII	CIII	Total	CIV	CV	CVI	CVII	CVIII	CIX	CX	Total	CXI	CXII	Total	CXIII	CIV
	4	4	4	12	4	4	4	4	4	4	4	12	4	4	8	4	4

Rubrics for project

Focus Areas:

1. **Problem Formulation (PO1,PO2, PO6,PO7)**
2. **Project Design (PO3)**
3. **Build (PO4,PO5,PSO1)**
4. **Test& Deploy (PO4, PO5,PSO2)**
5. **Ethicalresponsibility (PO8)**
6. **Team Skills (PO9)**
7. **ProjectPresentation (P10)**
8. **Projectmanagement (PO11)**
9. **LifelongLearning (PO12)**

Focus Areas	Criterion [c]	Exemplary 4	Satisfactory 3	Developing 2	Unsatisfactory 1
Problem Formulation (PO1,PO2, PO6, PO7)	**I - Identify/Define Problem** Ability to identify a suitable problem and define the project objectives.	Demonstrates a skillful ability to identify / articulate a problem and the objectives are well defined and prioritized.	Demonstrates ability to Identify / articulate a problem and All major objectives are identified.	Demonstrates some ability to identify / articulate a problem that is partially connected to the issues and most major objectives are identified but one or two minor ones are missing orpriorities are not established.	Demonstrates minimal or no ability to identify / articulate a problem and many major objectives are not identified.
	II - Collection of Background Information: Ability to gather background Information (existing knowledge, research, and/or indications of the problem)	Collects sufficient relevant background information from appropriate sources, and is able toidentify pertinant/critical information;	Collects sufficient relevant background information from appropriatesources;	Collects some relevant background information from appropriate Sources.	Minimal or no ability to collect relevant backgroundinformation
	III- Define scope of the problem Ability to identify problem scope suitable to the degree considering the impact on society and environment	Demonstrates a skillful ability to define the scope of problem accurately mentioning the relevant fields of engineering precisely. Considers, explainsand evaluates the impact of engineering interventions on society and environment.	Demonstrates ability to define problem scope mentioning the relevant fields of engineering broadly. Considers and explains the impact of engineering interventions on society and environment	Demonstrates some ability todefine problem scope mentioning some of the relevant fields. Some consideration of the impact of engineering interventions on society and environment.	Demonstrates minimal or no ability to define problem scope and fails to mention relevant fields of engineering. Minimal or no consideration of the impact of engineering interventions on society and environment
Project Design (PO3)	**IV- Understandingthe Design Process and Problem Solving:** Ability to explain the design process including the importance of needs, specifications, concept generation and to develop an approachto solve a problem.	Demonstrates a comprehensive ability to understand and explain a design process. Considers multiple approaches to solving a problem, and can articulate reason for choosing solution	Demonstrates an ability to understand and explain a design process. Considers multiple approaches to solving a problem, which is justified and considers consequences.	Demonstrates some ability to understand and explain a design process. Considers a few approaches to solving a problem; doesn't always consider consequences.	Demonstrates minimal or no ability to understand and explain a design process. Considers a single approach to solving a problem. Does not considerconsequences.

Build (PO4,PO5, PSO1)	**V- Implementing Design Strategy:** Ability to execute a solution taking into consideration design requirements using appropriate tool (software/hardware);	Demonstrates a skillful ability to execute a solution taking into consideration all design requirements using the most relevant tool.	Demonstratesanabilityto execute a solution taking into consideration design requirements using relevanttool.	Demonstrates some ability to execute a solution but not using most relevant tool.	Demonstrates minimal or no ability to execute a solution. Solution does not directly attend to the problem.
Test & Deploy (PO4, PO5, PSO2)	**VI- Evaluating Final Design:** To evaluate/confirm the functioning of the final design. To deploy the project on the target environment	Demonstrates a skillful ability to evaluate/confirm the functioning of the final design skillfully, with deliberation for further Improvement after deployment.	Demonstrates an ability to evaluate/confirm the functioning of the final design. The evaluation is complete and has sufficient depth.	Ability to evaluate/confirm the functioning of the final design, but the evaluation lacks depth and/or is incomplete.	Demonstrates minimal or no ability to evaluate/confirm the functioning of the final design.
Ethical responsibility (PO8)	**VII - Proper Use of Others' Work:** Ability to recognize, understand and apply proper ethical use of intellectual property, copyrightedmaterials, and research.	Always recognizes and applies proper ethical use of intellectual property, copyrighted materials, and others' research.	Recognizes and applies proper ethical use of intellectual property, copyrighted materials, and others' research.	Some recognition and application of proper ethical use ofintellectual property, copyrighted materials, and others' research.	Minimal or no recognition and/or application of proper ethical use of intellectual property, Copyrighted materials, or others'research.
Team Skills (PO9)	**VIII - Individual Work Contributions and Time Management:** Ability to carry out individual Responsibilities and manage time (estimate, prioritize, establish deadlines/ milestones, follow timeline, plan for contingencies, adapt to change).	Designated jobs are accomplished by deadline; completed work is carefully and meticulously prepared and meets allrequirements.	Designated jobs are accomplished by deadline; completed work meets requirements.	Designated jobs are accomplished by deadline; completed work meets most requirements.	Some Designated jobs are accomplished by deadline; completed work meetssome requirements.
	IX - Leadership Skills: Ability to lead a team. (i) Mentors and accepts mentoring fromothers. (ii) Demonstrates capacity for initiative while respecting others' roles. (iii) Facilitates others' involvment. (iv) Evaluates team Effectiveness andplans for improvements	Exemplifies leadership skills.	Demonstrates leadership skills.	Demonstrates some leadership skills at times.	Demonstrates minimal or no Leadership skills.
	X - Working with Others: Ability to listen to, collaborate with, and champion the efforts of others.	Skillfully listens to, collaborates with, and champions the efforts of others.	Listens to, collaborates with, and champions the efforts of others.	Sometimes listens to, collaborates with, and champions others' efforts.	Rarely listens to, collaborates with, or champions others' efforts.

Project Presentation (P10)	**XI - Technical Writing Skills** Ability to communicate the main idea with clarity. Ability to use illustrations properly to support ideas (citations, position on pageetc)	Main idea is clearly and precisely stated. Materials are seamlessly arranged in a logical sequence Illustrations are skillfully used to supportideas	Main idea is understandable. Material moves logically forward, Illustrations are properly used to supportideas	Main idea is somewhat Understandable. Material has some logical order and is somewhat coherent or easy to follow. Illustrations are for the most part properly used to support ideas	Main idea is difficult to understand. Material has little logical order, and is often unclear, incoherent. Illustrations are used, but minimally support ideas. (not properly cited etc)
	XII - Communication Skills for Oral Reports Ability to present strong key ideas and supporting details with clarity andconcision. Maintain contact with audience, and ability to complete in the allotted time	Presentation logically and skillfully structured. Key ideas are compelling, andarticulated with exceptional clarityand concision. Introduction, supporting details and summary are clearly evident and memorable, and ascertain the credibility of the speaker Presentation fits perfectly within timeconstraint.	Presentation has clear structure and is easy to follow. Key ideas are clearly and concisely articulated, andare interesting. There is sufficient detail to ascertain speaker's authority, and presentation includes an introduction and summary. Presentation fits within time constraint, though presenter might have to subtly rush or slow down.	Presentation has some structure. Key ideas generally identifiable, although not very remarkable. Introduction, supporting details and/or summary may be too broad, too detailed or missing. Credibility of the speaker may be questionable at times. Presentation does not quite fit within time constraint; presenter has to rush or slow down at end	Presentation rambles. Not organized; key ideas are difficult to identify, and are unremarkable. No clear introduction, supporting details and summary. Speaker has no credibility. Presentation is unsuitablably short or unreasonablylong.
Project management (PO11)	**XIII - Monitoring and Controlling the Project**	Monitors timelines and progress toward project goals on a daily basis. Provides accurate, complete reports of project progress.	Monitors timelines and progress toward project goals most of the time. Provides relatively accurate, complete reports of project progress with only mi nor errors or omissions	Seldom monitors timelines and progress toward project goals. Provides relatively acc urate, yet clearly incomplete, reports of project progress	Does not monitor timeline s and progress toward project goals. Provides inaccurate, incomplete reports of project progress
Lifelong Learning (PO12)	**XI V - Extend Scope of Work:** Ability to extend the project through implementation in other studyareas	Demonstrates a skillful ability to explore a subject/topic thoroughly, discusses the road map to extend the project in otherareas.	Demonstrates an ability to explore a subject/topic, and shows possible areas in which project can be extended	Demonstrates some ability to explore a subject/topic, providing some knowledge of areas in which project can beextended	Demonstrates minimal or no ability to explore a subject/topic, and does not discuss future work clearly mentioning other areas