**AquaSafe: Real-Time River Safety Monitoring**

**Higher National Diploma in Software Engineering**

**IOT Project Proposal**

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**Table of Contents**

**Content Page**

[**Chapter 1: Introduction 1**](#_Toc195357597)

[1.1 Introduction 1](#_Toc195357598)

[1.2 Problem Definition 1](#_Toc195357599)

[1.3 Proposed Solution 1](#_Toc195357600)

[**Chapter 2: Objectives 1**](#_Toc195357601)

[**Chapter 3: System Overview 1**](#_Toc195357602)

[3.1 System Architecture 1](#_Toc195357603)

[3.2 Workflow 1](#_Toc195357604)

[**Chapter 4: Technical Details 1**](#_Toc195357605)

[**Chapter 5: Project Plan 1**](#_Toc195357609)

[5.1 Timeline 1](#_Toc195357610)

[5.2 Milestones 1](#_Toc195357611)

[**Chapter 6: Budget 1**](#_Toc195357612)

[**Chapter 7: Conclusion 1**](#_Toc195357613)

[**Chapter 8: Appendices 1**](#_Toc195357614)

[8.1 References 1](#_Toc195357615)

[8.2 Team 1](#_Toc195357616)

[8.3 Diagrams 1](#_Toc195357617)

# Chapter 1: Introduction

## **Introduction**

In recent years, IOT(smart connected devices) have changed the way how we collect and share information. These devices are useful for monitoring rivers in Sri Lanka, where many people use rivers on a daily basis for bathing, swimming and enjoyment, because they can use low – cost sensors to the environmental conditions in real – time.

## **Problem Definition**

With the historic and economic significance of Sri Lanka’s rivers, unexpected changes in water depth, current speed, temperature, water quality(turbidity) and rainfall may cause risks. Due to incorrect information weak alert systems, and decisions depends on human judgments, many accidents occur.

## **Proposed Solution**

Through the use of many sensors connected to a NodeMCU controller, our project uses advanced technology to continuously track river conditions. Water depth, current speed, temperature, water quality(turbidity) and rainfall data are all gathered by the system, which analyzes it quickly and shows the findings on a web interface.

AquaSafe includes AI-powered safety predictions, allows users to report conditions, and tracks historical trends for better understanding patterns.

People can easily scan QR codes to see whether the water is safe before entering; the system is made to expand as needed and stay user-friendly.

This system will:

* Enhance public safety and reduce accidents.
* Support responsible tourism and community awareness.
* Enable research and data collection for environmental agencies.

# Chapter 2: Objectives

# As a project that aims to prevent any river accidents from happening this need to be capable of real time monitoring using IoT system. So that this system can give accurate and up-to-date response though the platform. To that end there are a few objectives that need to be achieved which are,

# Development of IoT monitoring system which can collect real-time data such as depth, current speed, temperature, turbidity, and rainfall.

# AI model to determine the risk level which will use collected data determine whether it safe to swim by classifying its conditions as “Safe,” “Caution,” or “Danger.”

# Development of the web application which is required to convey the collected data and conclusions reached by using graphs and such indicator which is accessible by using a QR codes.

# Allow the community to provide insights by using the same platform collect community perspective of the environment regarding rivers.

# Chapter 3: System Overview

## **3.1 System Architecture**

The AquaSafe system architecture is made up of a number of interrelated parts that work together to provide real-time river safety monitoring. From sensing to data display, the system is divided into several layers, allowing for constant data flow and easy access.

### **3.1.1 High-Level Architecture**

### **3.1.2 Detailed Layered Architecture**

Web Application

## **3.2 Workflow**

1. Sensing Environmental Data

Ultrasonic, Flow, Turbidity, Temperature, and Rain sensors are installed in the river environment to continuously monitor key parameters such as:

* Water depth
* Current speed
* Water temperature
* Water turbidity
* Rainfall levels

1. Data Collection by NodeMCU

The NodeMCU microcontroller (ESP8266) receives all sensor data, processes it, and prepares it for wireless transmission.

1. Transmission to Cloud Server

The NodeMCU uses Wi-Fi connectivity to transmit the gathered data to Firebase, a cloud-based server, where it is saved and made accessible additional analysis.

1. AI-Powered Safety Prediction

To determine risk levels, a machine learning model (located on the server) analyses both historical and real-time data. It divides the state of the river into three groups:

* Safe
* Caution
* Danger

1. Web Application Interface

A responsive web application shows the processed results and safety calculations. The platform also provides:

* Visual graphs of historical trends
* Real-time sensor data
* Community-submitted hazard reports

1. User Access via QR Code

At the river location, users can instantly access the web application by scanning a QR code that is placed on a signboard. This allows them to verify the most recent river safety status prior to going into the water.

# Chapter 4: Technical Details

# This system perfectly combines modern emerging technologies such as IoT, AI-based analytics and a modern web interface to get input, process and output. This is done by a set of hardware and software components which are,

# Hardware Components

# Microcontroller: NodeMCU (ESP8266) which is used to manage sensors and transmit their data using Wi-Fi.

# Sensors:

# Ultrasonic Sensor: Measures water depth.

# Flow Sensor: Detect water flow and speed.

# Temperature Sensor: Measures water temperature.

# Turbidity Sensor: Monitors water clarity and any contamination happened.

# Rain Sensor: detect rain fall.

# Power Supply: Rechargeable batteries.

# Connectivity: Wi-Fi communication via NodeMCU to a cloud server.

# Software Components

# Frontend: Built with React.js + Material UI+chart.js for a visually engaging user-friendly web interface.

# Backend: REST API developed using Spring Boot for handling sensor data and Flask-based API for AI predictions as well as Firebase as data storage.

# AI/ML Model:

# Trained using Python (with Random Forest or XGBoost).

# Inputs: Depth, flow, temperature, turbidity, rainfall, weather.

# Output: River safety status (“Safe”, “Caution”, “Danger”).

# Data Transmission: Sensor data is transferred using HTTP protocols as per request or MQTT on regular intervals.

# QR Code Access: QR codes used to access the website which allow any user to view the website instantly on any device.

# 

# Chapter 5: Project Plan

# The project is structured as multiple segments which is ordered in the most suited way to ensure the project meets the deadline on time covering all the necessary tasks which are simply finding system requirements, planning and prototyping then deployment and testing.

## **5.1 Timeline**

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## **5.2 Milestones**

**Phase 1: Research and Planning**

* Identify a problem and find a solution in case safety of river locations in Sri Lanka.
* Identify which are system requirements such as what sensors collect what data for what purpose.
* Confirm the finalized system and its components.

**Phase 2: Hardware Integration**

* Collecting the sensors and components needed such as NodeMCU, ultrasonic sensor, flow sensor, turbidity sensor, DS18B20 temperature sensor and rain sensor.
* Assembling and testing sensors using the NodeMCU microcontroller.
* Ensure data readings are accurate and meet project requirements.

**Phase 3: Software Development**

* Development of website’s frontend using React.js with Material UI and chart.js for user interaction.
* Creating backend APIs which are integrated with Firebase ensure real-time stream of data.
* Training and integrating the AI model to backend as an API.

**Phase 4: Integration and Deployment**

* Finally combine IoT system with websites.
* Check live sensor data streams within the website.
* Make QR codes access the website.
* Deploy the system and test outputs.

**Phase 5: Testing and Feedback**

* Ensure the accuracy and reliability of the system’s output.
* Do improvements based on the system’s needs.
* making documentation for project based on results.

# Chapter 6: Budget

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Quantity | Unit Cost (LKR) | Total (LKR) |
| NodeMCU (ESP8266) | 1 | 1200 | 1200 |
| Ultrasonic Sensor | 1 | 250 | 250 |
| Flow Sensor | 1 | 800 | 800 |
| DS18B20 Temperature Sensor | 1 | 350 | 350 |
| Turbidity Sensor | 1 | 2500 | 2500 |
| Rain Sensor | 1 | 250 | 250 |
| Battery | 1 | 800 | 800 |
| Miscellaneous (wires, casing, etc.) | - | - | 2000 |
| Total Estimated Cost |  |  | 8150 LKR |

# Chapter 7: Conclusion

# An inventive and much required way to improve public safety around Sri Lankan rivers is the AquaSafe system. This system provides users with precise, fast, and easy-to-use information regarding river conditions by combining IoT technology, real-time sensor data, and AI-based safety predictions.

# In addition to preventing accidents, the project promotes ecotourism and raises awareness in the local community by facilitating early warnings and improved environmental understanding. The technology encourages ethical usage of natural water bodies by ensuring that anybody may receive safety updates promptly through QR code access.

# The project shows how cutting-edge technology like sensors, cloud computing, artificial intelligence, microcontrollers, and web development may be combined to tackle practical issues. It also lays the groundwork for future developments, such incorporating weather forecasts, creating mobile applications, or working with the government to expand its use.

# In the end, AquaSafe is a step towards a more intelligent, secure, and sustainable relationship with the environment rather than just a technological endeavour.

# Chapter 8: Appendices

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