Web Application to Track Water Quality in Different Locations

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***Abstract*—This paper presents a web application that aims to make it easy for everyone to keep track of water quality in different locations. To achieve this, the application uses HTML, CSS and JavaScript for the front-end along with Python Flask for the back-end and a relational database system which is MySQl. The applications responsive design ensures reliable access enabling users to effortlessly stay updated on water quality. The paper explores the development process, technological implementation of the application.**

I. Introduction

The need for easily available technologies to monitor water quality in different locations has increased in recent years due to growing worries about water contamination. Understanding the significant influence that water quality has on public health, we embarked on developing an intuitive web application that enables people to keep a close eye on the water quality in their immediate area. The application aims to provide a smooth user experience by using Python Flask for the back-end and HTML, CSS, and JavaScript for the front-end.The core focus was on establishing a straightforward database to store vital parameters such as pH, dissolved oxygen, and pollutants.

This paper details the development of the application, emphasizing key technologies and user-friendly features that enhance accessibility. The primary objective is to contribute to a collective understanding of water quality trends, encouraging and increasing awareness about water safety through water quality monitoring. Subsequent sections delve into the methodologies employed, takes a deep dive into the design of the database, the significance of the study, and the potential impact on raising awareness in safeguarding water quality across regions.

II. Literature Review

Extensive research was done to gather as much knowledge and idea about preexisting systems and applications in order to have a proper understanding and clear vision of how this particular application needed to be within our scope. All the papers reviewed are individually summarized below.

A. Paper 1: A Low-Cost Multi-Parameter Water Quality Monitoring System [1]

The research describes a low-cost water quality monitoring system that uses electrochemical sensors and a smartphone app to evaluate free chlorine, temperature,pH, and BPA. The paper claims that the system can provide real-time and reliable data for environmental monitoring. The manufacturing, calibration, and testing of the sensors, as well as the design and execution of the readout circuit and the smartphone app, are all included in the article. The paper reports that the system can achieve high sensitivities for the water quality parameters.

B. Paper 2: Water Quality Monitoring with Arduino Based Sensors [2]

The paper presents a prototype of an Arduino-based sensor system for water quality monitoring. The system gauges the pH, temperature, turbidity, and total dissolved solids of the water. The system is made to be affordable, dependable, and real-time. The system was tested at a lake in Brunei for four weeks and the results were compared with a commercial water quality meter. The paper discusses the challenges and limitations of the system, as well as the future work to improve it.

C. Paper 3: Monitoring of water quality in a shrimp farm using a FANET [3]

The study presents a design for monitoring water quality in shrimp farms using Flying Ad-Hoc Networks (FANETs). It highlights the essential water quality criteria for the growth and well-being of shrimp. It is suggested to use controlled mobility in a mobile sensing platform based on FANETs to improve spatial monitoring. After conducting laboratory testing, the authors intend to present this method to Mexican shrimp farmers, highlighting the significance of regular water quality monitoring for farm profitability.

D. Paper 4: State of the Art Techniques for Water Quality Monitoring Systems for Fish Ponds Using IoT and Underwater Sensors: A Review [4]

In-depth reviews of water quality monitoring systems (WQSN) that use IoT and underwater sensors that were created by researchers between 2011 and 2020 are done in this research. It highlights how vitally important clean water supplies are and how ongoing monitoring is required because of pollution, contamination, and climate change. The drawbacks of conventional water quality monitoring systems—manually collected samples and laboratory analysis—are emphasized. The authors suggest many WQSNs that employ wireless sensor networks (WSN) based on the Internet of Things (IoT) to continually monitor parameters including temperature, turbidity, pH, dissolved oxygen, and electrical conductivity. Furthermore, the gathered data is analyzed by machine learning algorithms, which also offer early alerts for problems with water quality. The discussion of significant accomplishments, success metrics, and recommendations for future WQSN research directions round up the report.

E. Paper 5: Spatio-temporal analysis of water quality for pesticides and other agricultural pollutants in Deduru Oya river basin of Sri Lanka [5]

The paper's main objective is to evaluate the water quality in Sri Lanka's Deduru Oya river basin, especially in regions that get a substantial amount of agricultural input. Between the 2019 dry season (Yala) and the 2019–2020 wet season (Maha), the authors collected 183 water samples every two weeks. 39 factors, such as pesticides, heavy metals, minerals, and physico-chemical characteristics, were examined in these samples. Although heavy metal residues were not identified in the water samples, but some pesticides that exceeded national legal limits were found in them. The use of pesticides in agriculture and natural mineralization are two primary causes of water contamination in the region, according to the research.

F. Paper 6: Low-Cost Internet-of-Things Water-Quality Monitoring System for Rural Areas [6]

The article describes a low-cost internet-of-things (IoT) system designed to track and record the quality of various water sources. It monitors the turbidity, pH, temperature, and other characteristics of the water in a rural community using a number of sensors. The study emphasizes how crucial water quality monitoring is to protecting human life, fostering economic growth, and upholding the natural order. In order to provide early alerts and avoid contamination, the authors offer a low-cost prototype method for monitoring and assessing water sources in rural regions as their final point.

G. Paper 7: Applications of Online UV-Vis Spectrophotometer for Drinking Water Quality Monitoring and Process Control: A Review [7]

The use of online UV-Vis spectrophotometers for process control and drinking water quality monitoring is discussed in the study. It talks about how these sensors are superior to more conventional approaches and emphasizes how they can quickly detect changes in water quality and record the events. The use of chemometrics for improved usability and the usage of UV-Vis spectrophotometers to measure various water quality parameters are also covered in the paper. Anomaly detection and early warning systems are also explored in this. The paper concludes by discussing the need for further research, including industrial-scale evaluation and integration with real-time water treatment control systems.

H. Paper 8: Water quality monitoring in smart city: A pilot project [8]

The system described in this work collects and displays high-frequency, real-time data on water quality from Bristol Floating Harbour, which is a component of Bristol, UK's smart city infrastructure. TThe system employs cloud computing, Internet of Things, and wireless sensor networks to track many aspects of water quality, including conductivity, pH, temperature, and dissolved oxygen. The feasibility and advantages of adopting such a system for urban water management and environmental protection are presented in the study.

I. Paper 9: Internet-based applications for interrogating 50 years of data from the South African national water quality monitoring network [9]

In order to study and visualize the data from South Africa's national water quality monitoring network, which has been in operation since the 1970s, the author created and used two web-based tools, which are described in the article. The paper shows how the applications can help researchers and managers to locate relevant historical data, identify spatial and temporal patterns and trends, and compare different water quality parameters and sites. The paper also discusses the challenges and limitations of the applications and suggests future improvements.

J. Paper 10: Water quality data for national-scale aquatic research: The Water Quality Portal [10]

The Water Quality Portal (WQP), an online service that offers access to more than 290 million water quality records from diverse sources in the United States and abroad, is introduced in the article. The document provides an overview of the WQP's data, standardized data model, data access, and services. The analysis of the seasonal variance in lake water clarity throughout the various areas of the continental U.S. in this research serves to further highlight the importance of the WQP data.

K. Paper 11: Data Conditioning Modes for the Study of Groundwater Resource Quality Using a Large Physico-Chemical and Bacteriological Database, Occitanie Region, France [11]

In the study of a large and diverse database containing various types of parameters (microbiological, chemical, physicochemical) related to water quality in the Occitanie region of France, extreme values (Z-scores ¿ 2.5) are frequently observed. These extreme values contain a significant amount of information, making it challenging to analyze the overall dataset effectively. To address this issue, the researchers tested three different data conditioning methods, comparing them to the use of raw data. The results showed that using a logarithmic transformation was the most effective approach. This transformation helped reveal relationships between E. coli content and the other parameters while reducing the impact of extreme values without completely removing them. This concentration of information improved the data's spatial structure and representation. Using the square root function for data conditioning also showed some improvement but not as much as the logarithmic transformation. Ultimately, these findings could lead to more efficient and cost-effective monitoring of water quality by Regional Health Agencies, enhancing the understanding of the associated processes and spatial distribution of water quality parameters.

L. Paper 12: The Surface Water and Ocean Topography (SWOT) Mission River Database. [12]

The SWOT satellite mission, launched in 2022, is the first to focus on monitoring Earth's surface water. It did provide data on global rivers over 100m wide, including water elevation, width, and slope. To effectively use this data, a static river database is needed. The SWOT River Database (SWORD) is introduced, consisting of river reaches (about 10 km long) and nodes (spaced about 200m apart within reaches). SWORD includes various hydrological and morphological attributes and can expand in the future. Before SWOT's launch, SWORD can be used for global river flow modeling and large-scale hydrological analyses using ground measurements and other satellite data.

M. Paper 13: Underwater Internet of Things in Smart Ocean: System Architecture and Open Issues. [13]

This paper explores the establishment of a ”smart ocean” by introducing the concept of the Underwater Internet of Things (IoT). It underscores the significance of comprehending the ocean's characteristics and characterizes the Underwater IoT as a potent technology for achieving this goal. The document delves into current advancements, forthcoming system designs, applications, difficulties, and unresolved matters linked to the Underwater IoT. It acknowledges that recent progress in autonomous underwater vehicles, intelligent sensors, communication technologies, and routing protocols are enabling the Underwater IoT. In the coming years, it is anticipated to form a network of interconnected underwater entities with self-learning and intelligent computational capabilities. The paper outlines a five-tier system structure and proposes that cloud computing, fog computing, and artificial intelligence will be instrumental in addressing current challenges and shaping the direction of future research endeavors within the realm of the Underwater IoT.

N. Paper 14: A comprehensive review of water quality monitoring and assessment in Nigeria. [14]

Nigeria, the world's most populated black nation with about 199 million people, faces a significant challenge as approximately 66.3 million Nigerians lack access to safe drinking water. This study systematically reviewed research findings on water quality monitoring and assessment in Nigeria over the past two decades. The country continues to struggle with enforcing water quality guidelines due to corruption within its socio-political environment.

The study examined the quality of surface water, groundwater, rainwater, and commercially available water, along with their pollution sources. Surface water quality is generally poor. Groundwater pollution results from landfill leachate, oil and gas exploration, sewage, and interactions with the base rock, leading to issues like the presence of lead and barium in groundwater. Rainwater's primary concern is its low pH, but it is relatively clean. Commercially available water, such as bottled or sachet water, is the best source of drinking water in Nigeria, with bottled water having higher quality than sachet water, which is often affected by microbe contamination.

The study suggests future perspectives in water quality monitoring and assessment, focusing on emerging contaminants and micro-pollutants, as well as utilizing internet-enabled technologies to improve the monitoring process.

O. Paper 15: Smart water quality monitoring system with cost-effective using IoT. [15]

Due to the population increase, urbanization, and pollution, the water quality has been declining over the course of time. Freshwater is becoming scarce for human life and agriculture. The decline in water quality leads to waterborne diseases from industrial pollution, fertilizers, and factory chemicals. The usual water quality monitoring methods are not strong enough to control water quality. Without real-time data, these methods are weak.

P. Paper 16: A Low-Cost AI Buoy System for Monitoring Water Quality at Offshore Aquaculture Cages [?]

The research, "A Low-Cost AI Buoy System for Monitoring Water Quality at Offshore Aquaculture Cages" by Hoang-Yang Lu et al. discusses the significance of water quality in aquaculture. The maintenance of appropriate water conditions is essential for the growth and health of aquatic animals.Traditional manual monitoring techniques require a lot of work and are prone to mistakes. The research offers a unique AI buoy system capable of collecting and analyzing water quality data on its own. This system makes use of AI and machine learning to identify anomalies, predict trends, and offer immediate steps to maintain ideal circumstances. Notable features include its emphasis on affordability and accessibility, which may generalize advanced water quality monitoring technologies for a wider spectrum of aquaculture consumers. This research offers a practical solution for offshore settings in the growing field of AI-based water quality monitoring systems in aquaculture.

Q. Paper 17: Generative adversarial networks for detecting contamination events in water distribution systems using multi-parameter, multi-site water quality monitoring. [?]

The study "Generative adversarial networks for detecting contamination events in water distribution systems using multi-parameter, multi-site water quality monitoring" by Zilin Li et al. addresses the crucial problem of contamination detection in water distribution systems. The detection of contamination events by conventional approaches often falls short of being thorough and quick. Anomalies suggestive of contamination are more easily and accurately detected because of recent developments in water quality monitoring that involve the integration of data from multiple sites and multiple parameters. In the study, generative adversarial networks (GANs) are used to simulate typical water quality patterns and spot unusual differences that could be signs of pollution. This innovative approach shows promise, but further research and practical application are needed to fully realize its potential for maintaining public health and ensuring the security of drinking water.

R. Paper 18: Assessment of urban river water quality using modified NSF water quality index model at Siliguri city, West Bengal, India. [?]

The research, "Assessment of urban river water quality using a modified NSF water quality index model at Siliguri city, West Bengal, India," addresses the important issue of urban river water quality in the context of rapid urbanization. Due to industrialization and population expansion, water contamination in urban areas tends to get worse. The research offers a modified version of the NSF Water Quality Index (WQI) model, highlighting the importance of identifying such models. The case study of Siliguri, India, provides information on river health and influences plans for pollution management and urban growth. In areas that are quickly urbanizing, it is essential to understand the water quality of urban rivers. In order to manage water resources effectively.

S. Paper 19: Application of digital PCR for public health-related water quality monitoring [?]

The work by Ananda Tiwari and colleagues addresses a significant public health concern and highlights the importance of using digital PCR (DPCR) technology in water quality monitoring to discover waterborne pathogens. While reliable, conventional monitoring techniques might not be able to catch newly developing pollutants. The detection of pathogens in water samples could be improved by the use of DPCR, an advanced molecular biology approach that offers increased sensitivity and precision. This work represents a significant step in the search for more precise and sensitive techniques for monitoring water quality in relation to public health. DPCR method optimization, sample processing methods, and cost-effectiveness and scalability assessments across various environmental settings might all be the subject of future research.

T. Paper 20: Water quality assessment using NSFWQI, OIP and multivariate techniques of Ganga River system, Uttarakhand, India. [?]

The research "Water Quality Assessment using NSFWQI, OIP, and Multivariate Techniques of Ganga River System, Uttarakhand, India" examines the assessment of the water's quality of the Ganga River while taking into account its cultural and ecological value as well as the difficulties faced by pollution. It makes use of a number of approaches, including the Organic Pollution Index (OIP) and the National Sanitation Foundation Water Quality Index (NSFWQI), along with multivariate methodologies, to thoroughly assess water quality. The study's conclusions are essential for responsible water resource management and environmental protection in the Ganga River basin, emphasizing the value of a comprehensive strategy to address water quality issues in this renowned river system.

U. Paper 21: Smart water quality monitoring system with cost-effective using IoT. [?]

Due to the population increase, urbanization and pollution, the water quality has been declining over the course of time. Freshwater is becoming scarce for human life and agriculture. The decline of water quality leads to waterborne diseases from industrial pollution, fertilizers, and chemicals from factories. The usual methods of water quality monitoring is not strong enough to control water quality. Without real-time data, these methods are weak.

V. Paper 22: Multi-step ahead modelling of river water quality parameters using Tensemble artificial intelligence-based approach. [?]

Hydro-environment is a hot topic as water quality maintenance has come significant with the growing world population. Low Dissolved Oxygen contents degrades the habitat of aquatic animals. This paper discusses collecting precise water quality data for management using AI.

W. Paper 23: Real-time remote monitoring of water quality: a review of current applications, and advancements in sensor, telemetry, and computing technologies. [?]

Due to the rising effects of population expansion and industrial pressures in coastal and inland locations, monitoring has become effective. Assessment of the condition of the world's water resources, implementation of preservation and cleanup programs, and evaluation of program performance become difficult without precise and continuous data collecting. The restricted temporal and geographical coverage of traditional field measurements makes it challenging to address problems like damaging algal blooms and pollution of oyster beds. In situ detectors are now being used for continuous data gathering throughout recent monitoring activities, both locally and remotely. This method enables early identification of trends and changes in crucial water quality indicators, giving decision-makers the knowledge, they need in real time to take appropriate action. Technology advances have increased the effectiveness, uniformity, and accessibility of data collecting.

X. Paper 24: Heavy metal water pollution: A fresh look about hazards, novel and conventional remediation methods. [?]

Climate change, industrialization, urbanization have become major reasons in the 21st century for water pollution. Among all the contaminants, Heavy metals are one of them. This work discusses the sources for heavy metals, the detection, removal, and water quality control.

Y. Paper 25: A Generalized Additive Model approach to evaluating water quality: Chesapeake Bay case study. [?]

In coastal and estuarine systems, efforts have been made to limit nutrient imports, battle problems like eutrophication, improve water quality, and protect aquatic ecosystems. Examples include European nutrient reduction directives and Danish Action Plans, which lowered nutrient imports into Danish coastal waterways. In the US, efforts to improve the Chesapeake Bay's water quality have been underway for more than three decades, including the establishment of a TMDL to control nutrients and sediment. It is challenging to explain how complex systems affected by physical, biogeochemical, and anthropogenic factors affect water quality. It is essential to comprehend how variables like freshwater flow, nutrient loading, climatic change, and dynamics of sediment-nutrient interactions interact. Since 1984, the Chesapeake Bay area has monitored the water quality, first with a seasonal Kendall-based methodology.

Z. Paper 26: Scale relationship between landscape pattern and water quality in different pollution source areas: A case study of the Fuxian Lake watershed, China. [?]

Exploring the intricate link between landscape configuration and water quality holds paramount importance in combating water pollution and informing watershed land use strategies. While previous studies typically take a holistic watershed approach, this investigation zeroes in on the multi-scale dynamics of landscape patterns within distinct pollution source areas, offering invaluable insights for local river management. Our study is anchored in the Fuxian Lake basin, a representative plateau lake locale, dissecting how landscape structure influences water quality through advanced analytical techniques such as redundancy analysis and multiple regression modeling.

. Paper 27: River Water Quality Index prediction and uncertainty analysis: a comparative study of machine learning models. [?]

This journal delves into the intriguing realm of river water quality index prediction and conducts a comprehensive comparative analysis of various machine learning models. With a focus on unraveling the complexities of water quality assessment, the research seeks to enhance our understanding of how machine learning can contribute to the prediction of water quality indices, a critical aspect of environmental management and sustainability. The study meticulously investigates a diverse array of machine learning models, each armed with its unique strengths and capabilities. Through rigorous evaluation and comparison, the research aims to shed light on which models excel in the task of forecasting water quality indices and which exhibit proficiency in uncertainty analysis. These insights are invaluable for environmental scientists, policymakers, and water resource managers who rely on accurate water quality predictions to make informed decisions about resource allocation, risk assessment, and environmental protection. In essence, this research promises to not only advance our understanding of water quality prediction but also to provide practical guidance for those entrusted with safeguarding our precious water resources.

. Paper 28: A survey on river water quality modelling using artificial intelligence models: 2000–2020. [?]

The surge in river contamination, attributed to the combined effects of climate change and human interventions, has spurred a growing body of research into river water quality prediction, risk assessment, and pollutant categorization. In confronting the intricate web of water-related data, artificial intelligence (AI) models have emerged as potent tools. These AI systems exhibit remarkable prowess in handling the nonlinearity, nonstationary, and unforeseeable fluctuations inherent to natural environments. Moreover, their attributes encompass robustness, cost-effectiveness, and adept decision-making capabilities, rendering them indispensable for river water quality surveillance, governance, and the pursuit of environmental sustainability. This comprehensive survey embarks on an exploration of the untapped potential of AI models in addressing these multifaceted challenges.

. Paper 29: Microbial Indicators and Their Use for Monitoring Drinking Water Quality—A Review. [?]

This comprehensive review paper delves into the importance of microbial indicators in the surveillance of drinking water quality. It delves into the critical role that these indicators play in ensuring safe and potable water. The paper discusses the importance of microbial indicators, which are microorganisms used to assess the microbiological quality of drinking water. Common microbial indicators include coliforms, Escherichia coli (E. coli), and enterococci, among others. These microorganisms are valuable in indicating potential fecal contamination and the presence of pathogens that could pose health risks to consumers.

. Paper 30: Hybrid decision tree-based machine learning models for short-term water quality prediction. [?]

This research is dedicated to the development of innovative hybrid machine learning models, rooted in decision trees, designed to forecast short-term water quality. These models play a pivotal role in facilitating timely and efficient water resource management and safeguarding water safety for diverse applications. The study harnesses the power of decision tree models, renowned for their capability to handle intricate datasets and render transparent predictions. The "hybrid" nature of these models suggests their potential integration of components from various machine learning techniques or a fusion of diverse models, all aimed at enhancing the precision of water quality predictions. This research focuses on the critical task of predicting shifts in water quality parameters over relatively short time horizons, a fundamental element in managing and promptly responding to fluctuations in water quality conditions.

. Paper 31: Geospatial Technology based Water Quality Monitoring System for Bangladesh. [?]

The creation of a Geospatial Technology Based Water Quality Monitoring System (WQMS) for Bangladesh is the main goal of this project. The study evaluates the current monitoring system, pinpoints hotspots for water contamination, and establishes standards for key places. Based on the river's significance, length, and width as well as its varied uses, a total of 99 key places are chosen for 30 study rivers. The study creates a technique for collecting surface water samples and suggests 21 physiochemical characteristics for various water usage. The WQMS was created with GIS technology and uses Visual Studio, HTML, CSS, JavaScript, jQuery, and the EsriMapObject plugin for the front end and Microsoft SQL Server 2008 for the back end. Revision of standards, implementation of a web-based MIS, and prioritization of pollution hotspot-based monitoring are among the recommendations.

III. System Design

To design a working system for this particular web application, insight was taken from preexisting systems of reviewed research papers to determine an AS-IS system which describes a general overview of how similar preexisting systems function. A To-Be system was then formulated, which describes the proposed systems of this particular web application. Rich pictures of both these systems was then formulated.

A. As-is Rich Picture

The preexisting system is a simple one where sensors present in various water bodies detect and gather relevant water

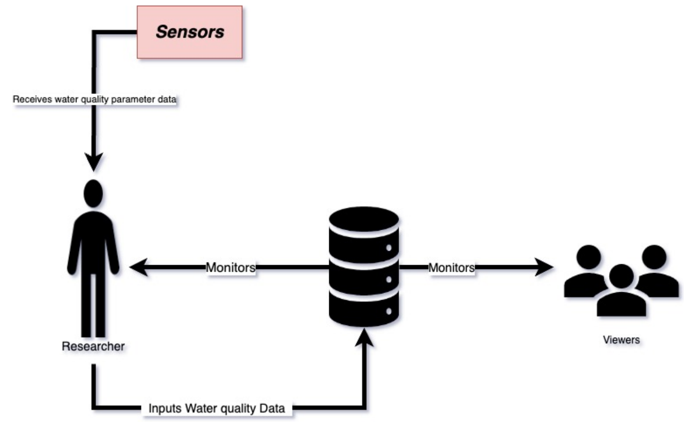


Fig. 1. As-is

parameter values. The researcher can then input the gathered data into the database. The data is then shown in a structured manner which both researchers and viewers can monitor.

B. To-be Rich Picture

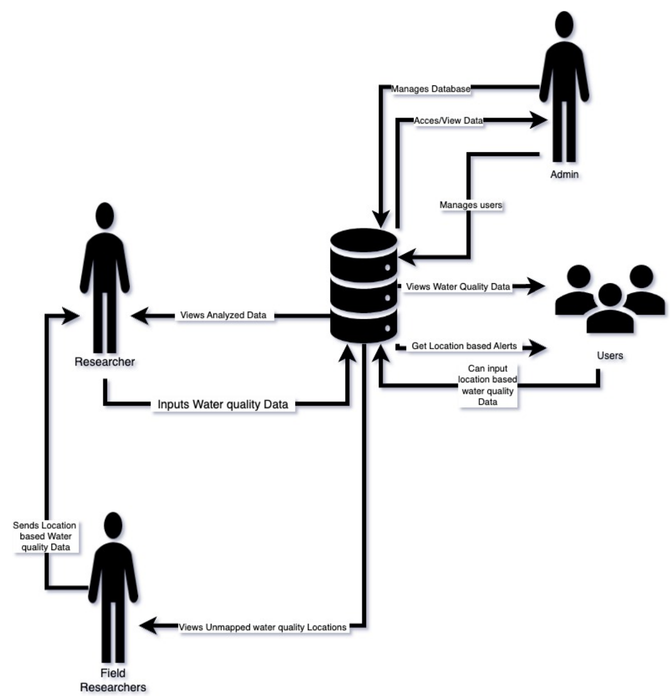


Fig. 2. To-be

In our proposed system, Users can be of two types but not limited to Researcher and Viewer.

All users will be identified using their user ID and they can access the database by providing their password.

Field researchers can view which water bodies have not yet been probed from the database and gather the data accordingly. The gathered parameter data is then sent over to the researchers as “WATER QUALITY DATA” and they will be able to input the data into the database for the appropriate location and water body. WATER QUALITY DATA can be identified using a unique ID and will contain its location as a foreign key along with all the relevant parameters and their values.

Viewers can also input data of water bodies yet to be collected and researched. Viewers are also allowed to view the quality index and all other relevant information about all water bodies, the data of which are already pre-existent in the database. Viewers will also be alerted about the risks and dangers of different water bodies based on their location. The alerts will be generated through determining factors by comparing the pre-existing water quality data for each respective body and the values from RECOMMENDED STANDARD. RECOMMENDED STANDARD will be identified using a unique ID and it will also contain a name, description and the minimum and maximum value for each parameter which will be termed as “Recommended Range” for that respective parameter.

An admin will have omnipotent control of the entire database. Admin will be able to access and view all data present in the database, he will also be able to manage or manipulate its different characteristics. Admin will also be able to manage all users present in the database. Users will be able to send support ticket requests to the admin and admins will be able to resolve them.

C. Entity Relationship Diagram

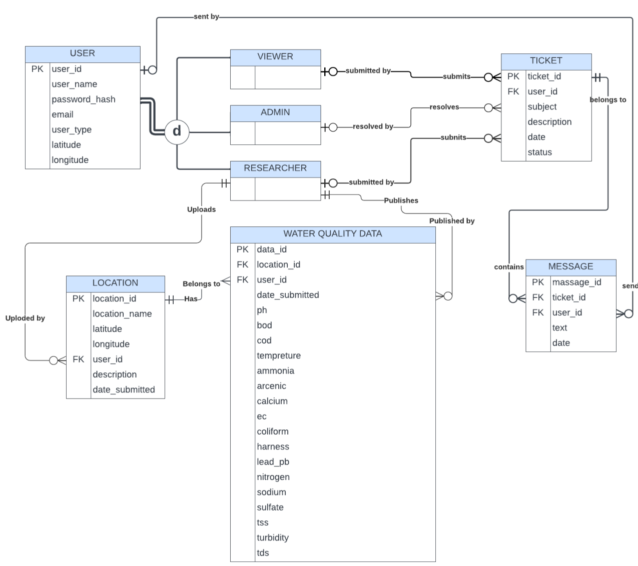


Fig. 3. Entity Relationship Diagram

- This ERD represents the data model of the database of this system. It consists of six entities: USER, VIEWER, ADMIN, RESEARCHER, WATER QUALITY DATA, LOCATION, TICKET, and MESSAGE.
- The USER entity is identified by the attribute user id (Primary Key). Other attributes include user name, password hash, email, user type, latitude, and longitude. Sub-types of this entity are ADMIN, RESEARCHER, VIEWER. The ADMIN entity is a type of USER who resolves TICKET. VIEWER can submit TICKET, which contains ticket id (Primary Key), user id (Foreign Key), subject, description, date, and status. These sub-types are specialized, meaning, only these three types of USER can exist and they are disjointed meaning no USER type can be of two types simultaneously. They must be unique.
- The RESEARCHER entity is a type of USER who submits WATER QUALITY DATA.
- The WATER QUALITY DATA entity contains attributes like data id (Primary Key), location id (Foreign Key), user id (Foreign Key), date submitted, and various water quality parameters like pH, bod, cod, temperature, ammonia, arsenic, ec, coliform, hardness, lead pb, nitrogen, sodium, sulfate, tss, turbidity, and tds. It is published by RESEARCHER. A RESEARCHER can publish many WATER QUALITY DATA but one WATER QUALITY DATA must be published by a single RESEARCHER.
- The LOCATION entity contains location information with attributes like location id (Primary Key), user id (Foreign Key), location name, latitude, longitude, description, and date submitted.
- The TICKET entity is connected to VIEWER who submit them and ADMIN who resolve them.
- The MESSAGE entity contains message information with attributes like message id (Primary Key), ticket id (Foreign Key), user id (Foreign Key), text, and date. It is contained in TICKET.

D. Schema

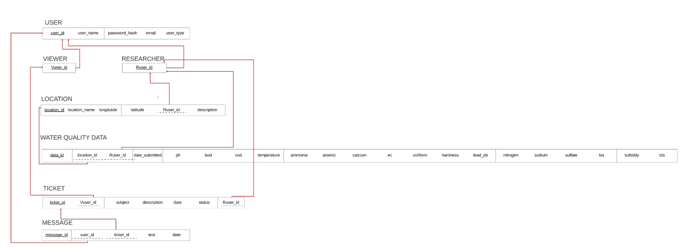


Fig. 4. Schema

Schema derived from the aforementioned ERD.

E. Normalized Schema

Since the goal was to build a simple and concise web app, and since the ERD turned out to not contain any composite keys or attributes of any kind, no further normalization is needed. It is already in the normal form.

F. Data Dictionary

USER

Name	Data Type	Size	Remark
user_id	INT		This is the primary key of this table. EG(1, 2, 3 ..)
user_name	VARCHAR	30	Unique username of each user.
password_hash	VARCHAR	255	Hashed password of the user.
email	VARCHAR	255	Email of the user.
user_type	CHAR	1	The role that the user has. EG(Admin, Researcher)
latitude	DECIMAL	10,6	Latitude values of the user
longitude	DECIMAL	10,6	Longitude values of the user

LOCATION

Name	Data Type	Size	Remark
location_id	INT		This is the primary key of this
location_name	VARCHAR	255	Name of each Location.
latitude	DECIMAL	10,6	Latitude values of the location
longitude	DECIMAL	10,6	Longitude values of the location
user_id	INT		The foreign key of the table USER table.
description	VARCHAR	6000	Location Description of the

WATER QUALITY DATA

Name	Data Type	Size	Remark
data_id	INT		This is the primary key of this table.
ph	FLOAT		Name of each Location.
bod	FLOAT		Water quality parameter
cod	FLOAT		Water quality parameter
temperature	FLOAT		Water quality parameter
ammonia	FLOAT		Water quality parameter
arsenic	FLOAT		Water quality parameter
calcium	FLOAT		Water quality parameter
ec	FLOAT		Water quality parameter
coliform	FLOAT		Water quality parameter
hardness	FLOAT		Water quality parameter
lead_pb	FLOAT		Water quality parameter
nitrogen	FLOAT		Water quality parameter
sodium	FLOAT		Water quality parameter
tss	FLOAT		Water quality parameter
turbidity	FLOAT		Water quality parameter
location_id	INT		Id of each location
user_id	INT		Id of each user
tds	FLOAT		Water quality parameter

TICKET

Name	Data Type	Size	Remark
ticket_id	INT		This is the primary key of this table. EG(1, 2, 3 ..)
user_id	INT		Id of the user who submitted the ticket.
subject	VARCHAR	255	The subject of the ticket.
date	TIMESTAMP		Time the ticket was submitted.
description	VARCHAR	6000	The description of the problem .
status	INT		The status the ticket is currently in EG(Resolved, Unresolved)

MESSAGE

Name	Data Type	Size	Remark
message_id	INT		This is the primary key of this table. EG(1, 2, 3 ..)
user_id	INT		Id of the user who sent the massage.
ticket_id	INT		The ticket that the massage belongs to.
date	TIMESTAMP		Time the message was sent..
TEXT	VARCHAR	2000	The text of the massage.

Fig. 5. Data Dictionary

In accordance with our ERD and Schema, proper data types and their sizes were selected. And they are as shown in the figure above.

IV. Methodology and Implementation

HTML, CSS and Javascript were used to build the front-end of the web application. HTML and CSS were used for visual pointers, to build the structure of the front-end itself and CSS was used to style the elements in accordance. Javascript was used as the scripting language for this app in areas where popup errors or confirmations were needed. Jinja web template engine was used in order to run various loops and conditional statements.

Python Flask was used for the back-end web framework for this app. Flask was chosen for its simplicity, flexibility, and ease of use. Flask is also what enabled for Jinja templating to take place. Python being a well known environment for its ease of use, and lightweight nature, Flask proves to be an extremely easy to maintain web framework to go for.

A. Search Page

The ”Search Data” page lets users quickly look for details about the water quality in particular locations. Users input their desired location into a clean and intuitive search bar, triggering a search process upon clicking the search button. Users are guided to a different page that shows all matched results.

The page also contains three other buttons. ”Add Location”, ”Compare Data Between Location”, ”View Random Location.

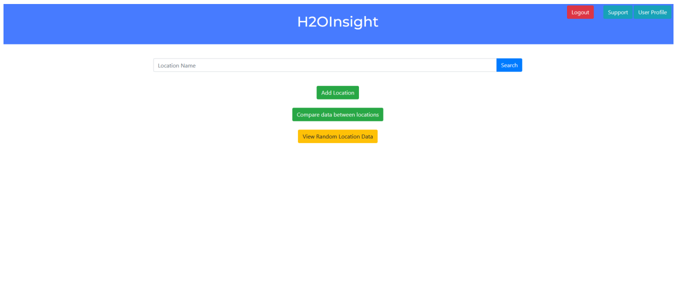


Fig. 6. Researcher Dashboard

The page navbar contains Log out, user profile and support. SQL query used to search for locations is `"SELECT * FROM locations WHERE location_name LIKE`

B. Add Location Page

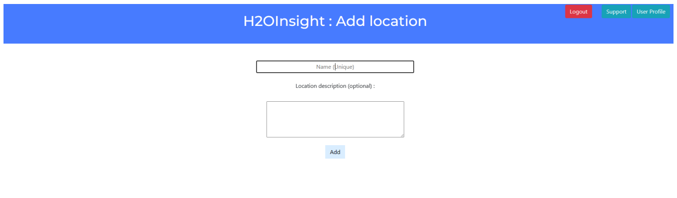


Fig. 7. Add Location Page

On this page, researchers can add a unique location to the database. The location name must be unique and adding a description is optional. The location will then be saved in the location table. The sql query looks like this: `"INSERT INTO locations (user_id, location_name, de`

C. Location Data Page

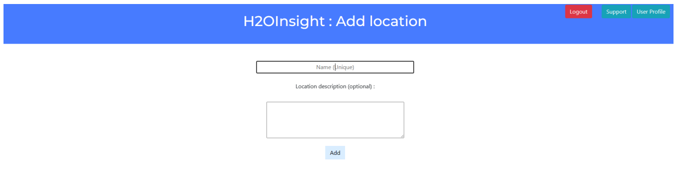


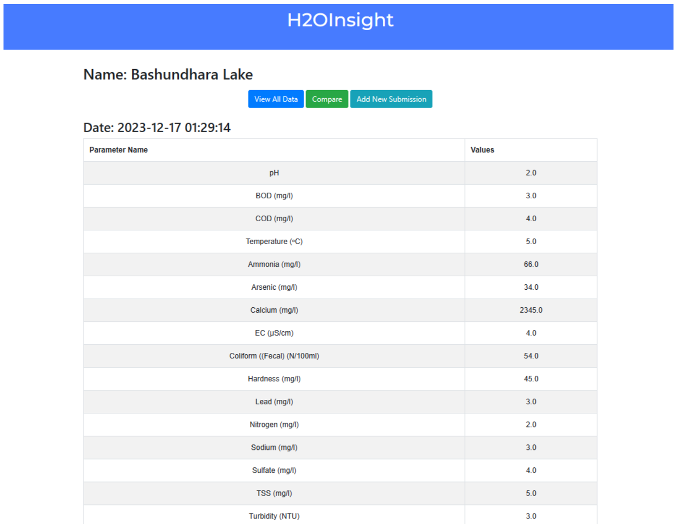
Fig. 8. Search Location Page

After searching for a particular location, this results page will show and after clicking on one of the results, it will redirect to the data for that particular location. Where all the parameters for that particular instance of that submission will be shown in tabular view.

D. Location Data View Page

E. Compare Data Page

Choosing compare data will take us to a page where we can select between two different instances of the same data differentiated by time, or we can also choose to compare between two entirely different locations. We can choose to compare in tabular view. We can also choose to compare in



H2OInsight

Name: Bashundhara Lake

View All Data | Compare | Add New Submission

Date: 2023-12-17 01:29:14

Parameter Name	Values
pH	2.0
BOD (mg/l)	3.0
COD (mg/l)	4.0
Temperature (ºC)	5.0
Ammonia (mg/l)	66.0
Arsenic (mg/l)	34.0
Calcium (mg/l)	2345.0
EC (µS/cm)	4.0
Coliform ((Fecal) (N/100ml)	54.0
Hardness (mg/l)	45.0
Lead (mg/l)	3.0
Nitrogen (mg/l)	2.0
Sodium (mg/l)	3.0
Sulfate (mg/l)	4.0
TSS (mg/l)	5.0
Turbidity (NTU)	3.0

Fig. 9. View Location Data Page

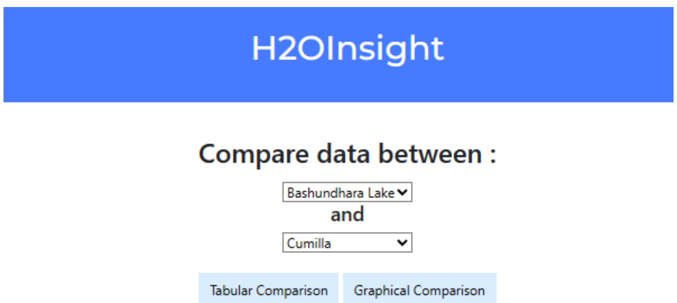


Fig. 10. Compare Page

graphical view where all the parameters are compared against each other in graphs.

F. User Profile

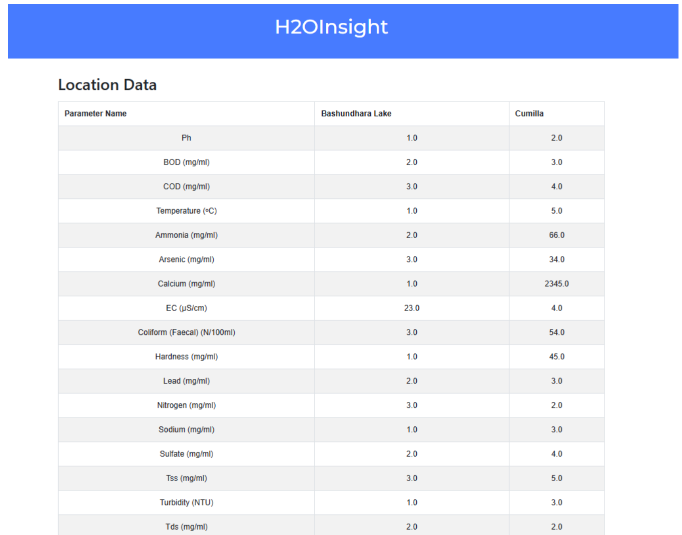
Users can also edit their profile information and change their password.

G. Admin Dashboard

Admin User will have some special functionalities. Admins will be able to edit registered user info, edit saved location info, delete users and locations and respond to unresolved ticket and send messages.

V. Result Analysis

Building the web app in a simple manner aligned with the goal of the project. Using simple yet powerful tools and going for a minimalist approach caused the development of a web app that is reliable, easy to use, but elegant and extremely useful at the same time.



H2OInsight

Location Data

Parameter Name	Bashundhara Lake	Cumilla
Ph	1.0	2.0
BOD (mg/ml)	2.0	3.0
COD (mg/ml)	3.0	4.0
Temperature (ºC)	1.0	5.0
Ammonia (mg/ml)	2.0	66.0
Arsenic (mg/ml)	3.0	34.0
Calcium (mg/ml)	1.0	2345.0
EC (µS/cm)	23.0	4.0
Coliform (Faecal) (N/100ml)	3.0	54.0
Hardness (mg/ml)	1.0	45.0
Lead (mg/ml)	2.0	3.0
Nitrogen (mg/ml)	3.0	2.0
Sodium (mg/ml)	1.0	3.0
Sulfate (mg/ml)	2.0	4.0
Tss (mg/ml)	3.0	5.0
Turbidity (NTU)	1.0	3.0
Tds (mg/ml)	2.0	2.0

Fig. 11. Tabular Comparison

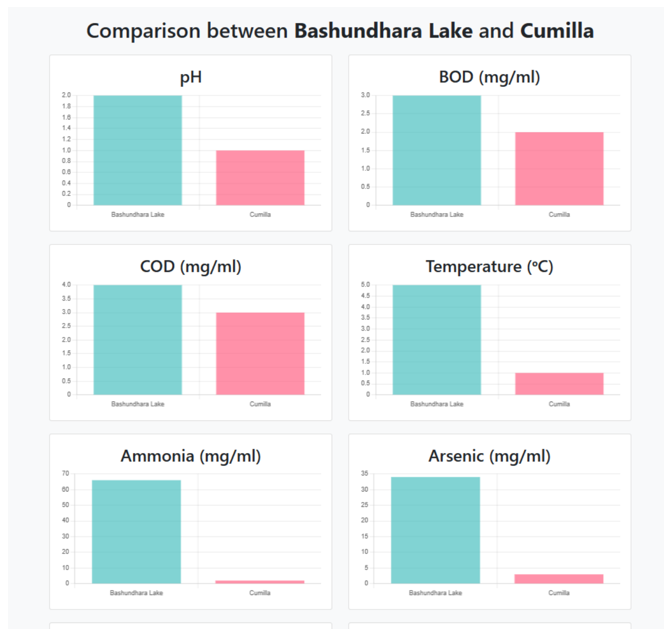


Fig. 12. Tabular Comparison

VI. Conclusion and Future Work

The contents of this document detail the creation of a web app designed to monitor water quality, system design, methodology, and implementation. The shift from the existing system, illustrated in the rich picture, to the proposed system signifies a move towards a more advanced and user-centric platform. The Entity Relationship Diagram (ERD), Schema, and Normalized Schema form a robust basis for structuring the database.

The selection of tools and technologies, such as HTML, CSS, JavaScript, and Python Flask, seems apt for achieving the

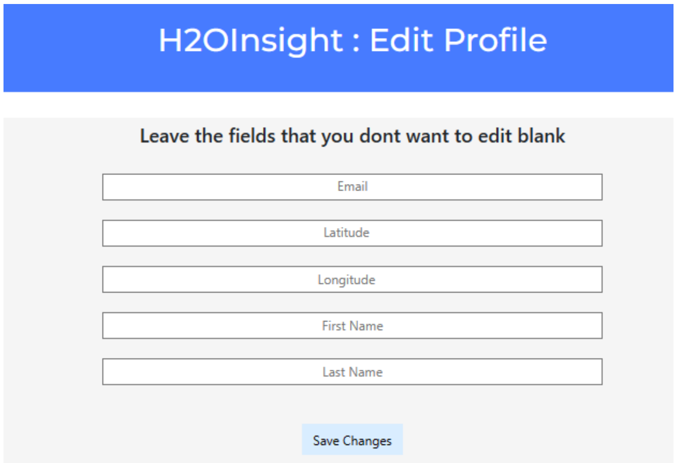


Fig. 13. Edit Profile

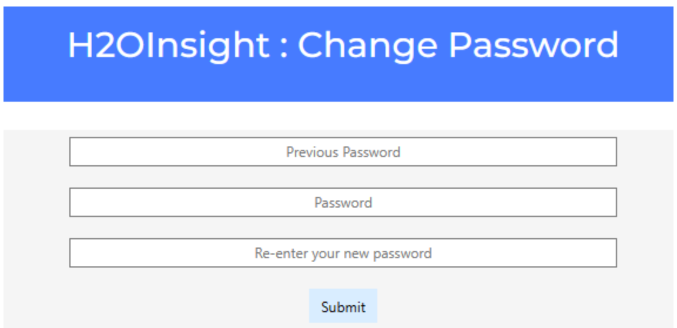


Fig. 14. Edit Profile

project's objectives. The creation of the frontend, exemplified by pages like the search page, add location page, and user profile, showcases interfaces that are intuitive for users. The backend functionalities, emphasized in the ERD and Schema sections, play a vital role as well.

To sum up, the design and execution of the web application have effectively achieved the specified goals. As for future endeavors and improvements, there is room for improvements such as incorporating extra functionalities like location based alerts to users, optimizing performance, and connecting with advanced data analysis or visualization tools.

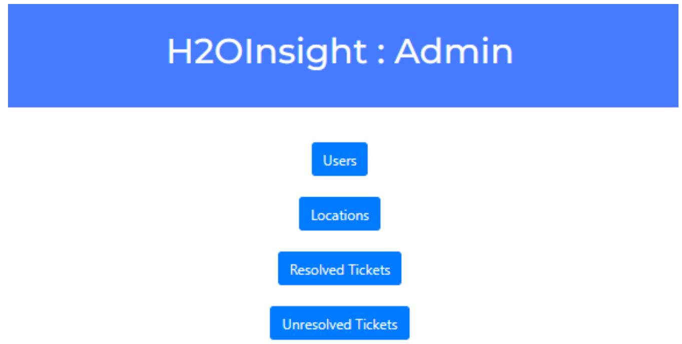


Fig. 15. Admin Dashboard

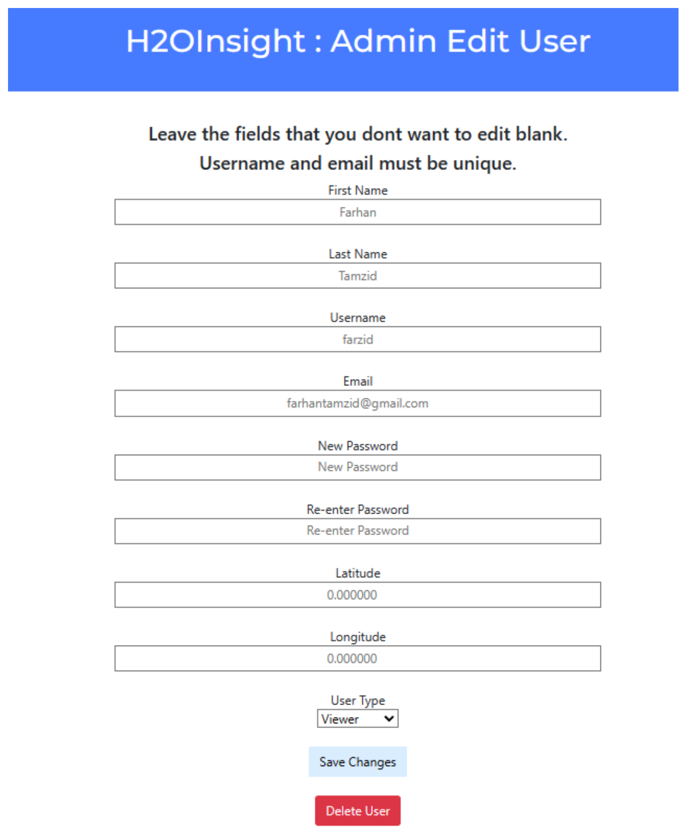


Fig. 16. Admin Edit User Page

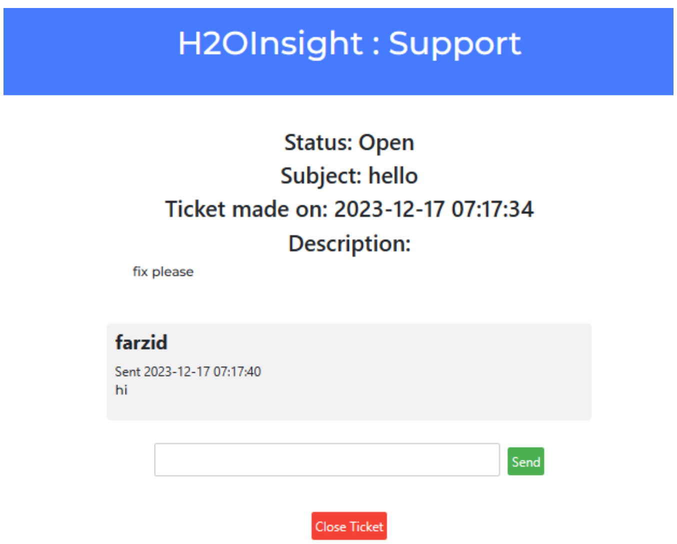


Fig. 17. Admin Support Page

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