Water4u

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ABSTRACT

"Water4U" is a mobile app developed to address the persistent challenge of clean water access in Pakistan. The app leverages GPS technology to help users find nearby clean water sources, offering real-time updates on availability.

Access to clean drinking water is a pressing issue, with only 57% of Pakistan's population having access to improved water sources. "Water4U" joins the ranks of similar apps globally, yet distinguishes itself by using crowd-sourced information and providing estimated wait times.

The project aims to provide accurate, real-time information on clean water sources' locations. The app includes features for locating sources, offering directions, reporting issues, and rating source quality. User feedback will drive continuous improvement.

In conclusion, the "Water4U" goal is to significantly enhance clean water access in Pakistan while serving as a model for similar initiatives worldwide.

CONTENTS

LIST OF FIGURES

Chapter No. 1 INTRODUCTION

1.1 BACKGROUND

Access to clean drinking water is a significant problem in many regions of Pakistan. According to a report by UNICEF and the World Health Organization, only 57% of the population in Pakistan has access to improved drinking water sources. This lack of access to clean water can have severe health consequences, such as water-borne illnesses and diseases. In response to this challenge, various initiatives have been launched to provide clean water to communities.

However, there is a need to develop innovative solutions that can reach a broader audience and ensure the sustainability of clean water access. A mobile app that helps users locate and access clean water sources can be a step in the right direction.

1.2 PROBLEM IDENTIFICATION

The problem being addressed by this project is the lack of access to clean water in many parts of the world, including Pakistan. Despite efforts by various organizations and governments, many people still struggle to find reliable sources of clean drinking water. This leads to health problems, as well as economic and social challenges.

The problem is especially acute in urban areas like Karachi, where the population is rapidly growing and the demand for clean water is increasing. There is a need for a solution that can provide people with accurate and up-to-date information about where to find clean water, as well as a way to report problems or issues with existing water sources. This project aims to address this problem by developing a mobile app that can help people locate clean water sources and share information about them.

1.3 AIMS

The primary aim of this research endeavor is to significantly enhance access to clean water throughout Pakistan by offering real-time information regarding the precise locations of clean water sources. This initiative seeks to address the pervasive issue of limited access to clean drinking water by harnessing the power of modern technology. In line with this overarching goal, the specific aim is to meticulously design and develop a cutting-edge mobile application.

This application will serve as a user-friendly and accessible tool, empowering individuals to effortlessly pinpoint clean drinking water sources within their immediate vicinity. By seamlessly integrating GPS technology, the app will provide users with accurate and up-to-date information on nearby water sources, enabling them to make informed decisions about their water consumption. This dual-fold aim is poised not only to contribute significantly to the mitigation of the clean water crisis in Pakistan but also to exemplify the potential of technology-driven solutions in addressing critical societal challenges.

1.4 OBJECTIVES

The first objective of this thesis is to develop an interactive map-based user interface that effectively displays the locations of clean drinking water sources in both urban and rural areas. This user-friendly interface will serve as a vital tool in helping individuals easily locate nearby sources of clean drinking water.

The second objective is to enable users to search for water sources within their vicinity through the developed application. This will include providing step-by-step directions to the selected water source and enhancing user accessibility and navigation, particularly in areas where access to clean water is a critical concern.

An essential aim of this research is to incorporate a reporting feature within the application, allowing users to promptly report any issues or changes related to the availability and quality of the water source. This real-time reporting capability is

designed to foster information sharing, community involvement, and continuous monitoring of water sources.

Another key objective is to design and implement a robust rating system for water sources. This system will focus on evaluating the reliability and quality of these sources, providing users with valuable insights to make informed decisions about their choice of water sources.

User testing is a fundamental component of this research. The objective is to conduct comprehensive user testing and actively gather feedback from the application's users. This iterative feedback loop will be crucial in refining and enhancing the application's features and usability, ensuring it meets the needs and expectations of the users.

The final objective is to contribute to the broader global effort of achieving the United Nations Sustainable Development Goal 6 (SDG 6). Specifically, the research aims to advance the goal of ensuring the availability and sustainable management of water and sanitation for all. The focus of this contribution is to improve access to clean drinking water in Pakistan, aligning with the global commitment to address water and sanitation challenges.

1.5 SCOPE

The scope of the project is to design and develop a mobile app that allows users to locate clean water sources in their vicinity and report on their availability. The app will use GPS to determine the user's location and display nearby water sources on a map. Users can then select a water source and get directions to reach it. They can also report on the availability of water sources by clicking a button in the app. This information would be updated in real time and displayed on the app's map to help other users find available water sources.

Chapter No. 2 BACKGROUND AND LITERATURE REVIEW

2.1 BACKGROUND

In today's rapidly evolving digital landscape, mobile technology has become an integral part of our daily lives, offering countless solutions to a wide range of global challenges. Among these challenges, ensuring access to clean and safe water remains a pressing concern for communities worldwide. With nearly 2.2 billion people lacking access to safe drinking water sources, innovative approaches are required to address this critical issue.

2.2 HISTORY OF MOBILE PHONES

The history of mobile phones traces a fascinating journey from the early concept of wireless communication to the sophisticated smartphones that have become an indispensable part of modern life. The groundwork for mobile communication was laid in the mid-20th century, with the invention of the first mobile phone by Martin Cooper at Motorola in 1973. This initial device, known as the Motorola DynaTAC 8000x, weighed nearly two pounds and had limited functionalities compared to contemporary smartphones.

The 1980s witnessed the commercialization of mobile phones, albeit with hefty price tags and limited coverage. The introduction of 2G (second-generation) mobile networks in the 1990s marked a significant leap forward, allowing for more reliable and widespread wireless communication. Nokia became a prominent player in this era, producing iconic devices like the Nokia 3310.

The 21st century ushered in the era of smartphones with the launch of the iPhone by Apple in 2007. This revolutionary device combined a mobile phone with a touchscreen interface, internet capabilities, and a range of applications. The

subsequent proliferation of smartphones led to the dominance of operating systems like Android and iOS, fostering a dynamic ecosystem of mobile applications [1].

2.3 HISTORY OF MOBILE APPLICATIONS

The evolution of mobile applications is intrinsically linked to the advancement of mobile technology. Early mobile phones featured simple built-in applications like calendars and calculators. However, the true surge in mobile applications occurred with the advent of smartphones. The Apple App Store, launched in 2008 alongside the iPhone 3G, played a pivotal role in popularizing third-party applications.

Initially, mobile applications were predominantly focused on basic utilities and entertainment. As smartphones became more powerful, the scope of applications expanded exponentially. The introduction of 3G and later 4G networks facilitated faster data transfer, enabling more sophisticated and data-intensive applications.

The app landscape diversified rapidly, encompassing categories such as social media, productivity, gaming, and healthcare. Google Play Store for Android devices further augmented the app ecosystem, contributing to a competitive and innovative market.

The emergence of cloud computing and the advent of 5G technology have continued to shape the trajectory of mobile applications. Cloud-based applications enable seamless synchronization across devices, while 5G promises faster download speeds and reduced latency, enhancing the user experience.

Today, mobile applications have become integral to various aspects of daily life, from communication and navigation to entertainment and business. The constant evolution of both mobile devices and applications ensures a dynamic landscape that continually pushes the boundaries of what is possible in the realm of mobile technology [2].

2.4 CLEAN WATER CHALLENGES

Ensuring access to clean water is a fundamental human necessity, yet a staggering one in four people worldwide lack access to safe drinking water, posing a significant health hazard. Unsafe water is a leading cause of over a million deaths annually,

contributing to the prevalence of infectious diseases like cholera, diarrhea, dysentery, hepatitis A, typhoid, and polio. Additionally, it exacerbates malnutrition, particularly affecting childhood growth. The rate of water consumption has outpaced population growth, and projections indicate that by 2025, around 1.8 billion people will reside in areas grappling with water scarcity. Two-thirds of the global population will inhabit water-stressed regions due to factors such as usage patterns, population expansion, and climate change [3].

2.4.1 CLEAN WATER CHALLENGES IN PAKISTAN

Pakistan stands out as one of the world's most water-stressed nations, with over 80 percent of its population experiencing severe water scarcity for at least one month each year. The country heavily relies on overdrawn groundwater resources, primarily for irrigation purposes. Without intervention, Pakistan could face nationwide water scarcity by 2025. Alarmingly, only two-thirds of available water is utilized, while a significant portion is lost or discharged into the sea. The country's shift from water abundance to water stress over recent decades is evident. Despite having 2.8 percent of the global population, Pakistan contributes only 0.5 percent to global renewable water resources. Endemic diarrheal diseases cause up to 100,000 deaths annually, constituting 33 percent of all deaths. The scarcity of safe water has driven the growth of the bottled water industry, although it poses its own set of risks [4].

2.5 USABILITY OF MOBILE APPLICATIONS

The ease of use of a mobile application is critical to its success. According to the literature review on mobile application usability, usability is typically measured by three attributes: effectiveness, efficiency, and satisfaction.

Other attributes, such as cognitive load, tend to be ignored in mainstream usability models, even though they are more likely to influence the success or failure of an application.

2.6 SIMILAR PROJECTS

Numerous mobile applications have been developed on a global scale with the primary objective of addressing the critical issue of providing access to clean water. For instance;

2.6.1 mWater:

mWater, created by former NASA employee John Feighery and his wife Annie Feighery, is a mobile application that records the results and precise locations of water quality tests on a mobile device. The app is used in 180 countries by over 75,000 governments, NGOs, health workers, and researchers. Users can add pictures and write notes on scent and appearance. They can also add data from new tests they've conducted using the $10 water testing kit available from the app. This makes mWater one of the most comprehensive apps for improving access to clean water [5].

2.6.2 Akvo Flow:

Akvo Flow is another significant mobile application that improves access to clean water. Founded by Peter van der Linde and Jeroen van der Sommen after meeting at the World Water Week conference in Stockholm, Akvo Flow aims to improve the way that water quality data is presented via open-source technology [6].

2.6.3 TaroWorks:

TaroWorks is a field service mobile app used by Impact Water to collect data. Impact Water delivers cost-effective, safe drinking water to schools through the installation and maintenance of water purification systems that use UV and chlorine treatment. The TaroWorks mobile application helps their field technicians give step-by-step guides for proper installation of the clean water purification systems and make subsequent maintenance visits to the schools they serve in Uganda [7].

2.7 IMPACT OF MOBILE APPLICATIONS

Studies have proven that these applications make a big difference. They help people understand water quality issues better and encourage them to make good choices. So, they're not only useful but also enjoyable to use

.

Chapter No. 3 ANALYSIS & DESIGN

3.1 METHODOLOGY

Making a software project work well depends on effective planning. Benjamin Franklin said, 'If you don't plan, you're planning to fail.' Before starting the project, we carefully make plans to decide how it will happen. These planning efforts are part of software development methodologies, which are roadmaps showing important steps for project development.

We choose a specific roadmap based on factors like project complexity and requirements. This decision, aiming to achieve the best results matching stakeholders' preferences, is a vital part of the planning phase in the Software Development Life Cycle (SDLC).

3.1.1 AGILE METHODOLOGY

The development of the Water4u mobile application follows the Agile Methodology, a dynamic and iterative approach to software development. Unlike traditional methodologies relying on detailed upfront planning, Agile emphasizes flexibility and collaboration throughout the development process. In the Agile framework, the project is divided into small, manageable units called iterations or sprints, enabling continuous assessment, adaptation, and improvement. This methodology is particularly suited for projects with evolving requirements, providing a responsive approach, as shown in Figure 3-1.

The decision to adopt Agile in this project is based on its ability to accommodate the dynamic nature of mobile application development and its potential to enhance

responsiveness to user needs and preferences [8].

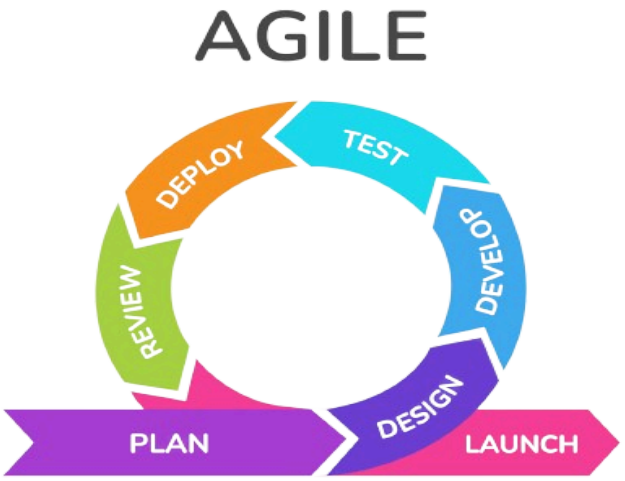

Figure 3-1 Agile Methodology

3.1.2 FUNCTIONAL REQUIREMENTS

Functional requirements of a system encompass the anticipated functions or actions. They are the functionalities necessary for users to accomplish their tasks.

Functional Requirements for the Water4u project are following;

Real-time Water Source Information:

- The app will be able to provide up-to-date information on the availability of clean water sources in the User's area through crowd-sourced data.

- Location-Based Services:
  - Users can easily find the location of nearby clean water sources on the map inside the app.
- Multilingual Support:
  - The application will be able to support both Urdu and English languages seamlessly.
  - Users can easily switch between Urdu and English within the app using the settings button.
- User Contribution:

- All users, without the need for registration, will be able to contribute real-time information about water sources to keep the data current.

- Easy-to-Use Interface:
  - The app will have a straightforward and user-friendly interface, ensuring accessibility for people with different levels of education and technical skills.

3.1.3 NON-FUNCTIONAL REQUIREMENTS

Non-functional requirements address aspects of the system's operation that are not tied to specific behaviors or features but are essential for overall performance, reliability, and user experience.

Here are some non-functional requirements for the Water4u project:

- Usability:
  - The user interface will be intuitive and easy to navigate, catering to users with varying levels of digital literacy.
- Maintainability:
  - The application will be designed with modularity and ease of maintenance in mind, facilitating updates and improvements over time.
- Performance:
  - The application will be able to provide real-time or near-real-time updates on water resource information to the users.
- Scalability:
  - The application will handle a growing number of users and water resource data without significant performance degradation.

3.2 DESIGN OF WATER4U APPLICATION

The system design phase, a critical stage in the software development life cycle (SDLC), involves translating specified requirements into a detailed and feasible

blueprint for constructing a software system. This stage is dedicated to defining the system architecture, modules, interfaces, and data, ensuring they align with the specific requirements.

3.2.1 USE CASE

A use case diagram is a visual representation in Unified Modeling Language (UML) that provides an overview of the functional requirements and interactions between the various actors and use cases in a system.

The focus is on expressing how users (actors) interact with the system to achieve a specific goal or task.

3.2.1.1 USE CASE FOR USERS

The use case diagram in Figure 3-2 illustrates that the application user can engage in various actions related to discovering and reporting water resources. This involves locating water sources, receiving directions to them, checking water availability at specific locations, and, in case of inaccuracies, providing feedback. Users also have the option to contribute to the system by adding new water resources. Moreover, the system actively encourages user feedback on both its overall functionality and the accuracy of resource information

Figure 3-2 Use Case for User

3.2.1.2 USE CASE FOR ADMIN

In the use case diagram depicted in Figure 3-3, the administrator assumes a central role in overseeing and managing various aspects related to water resources. The admin can locate and manage water resources, ensuring the accuracy and currency of information within the system.

The admin also possess the authority to check water availability, report discrepancies, add new water resources, and offer valuable feedback. Moreover, administrators can manage users, overseeing user-related functions within the system. This comprehensive administrative control empowers admins to contribute, verify, and maintain the integrity of water resource information, thereby fostering effective management and collaboration.

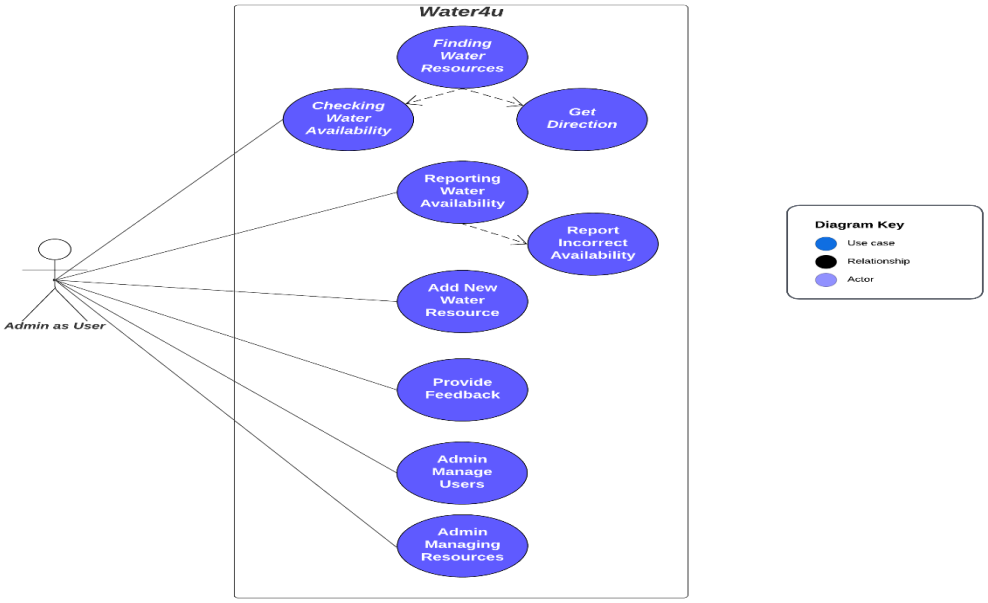

Figure 3-3 Use case for Admin

3.2.2 ACTIVITY DIAGRAM

An activity diagram is a type of Unified Modeling Language (UML) diagram used in software development to visually represent the flow and sequence of activities within a system or process.

It provides a dynamic view of the system, highlighting the workflows and actions performed by different entities to achieve specific goals.

3.2.2.1 ACTIVITY DIAGRAM FOR USER

The Activity diagram in Figure 3-4 reveals that, upon launching the application, users can select from various menu options, each leading to distinct paths. These paths include adjusting language settings, adding new water source locations to the

database, or initiating a process to discover nearby water sources. The app utilizes GPS coordinates to showcase the closest water source locations, allowing users to choose a destination, view the route, and commence navigation. Following the journey, users have the option to provide a review if desired.

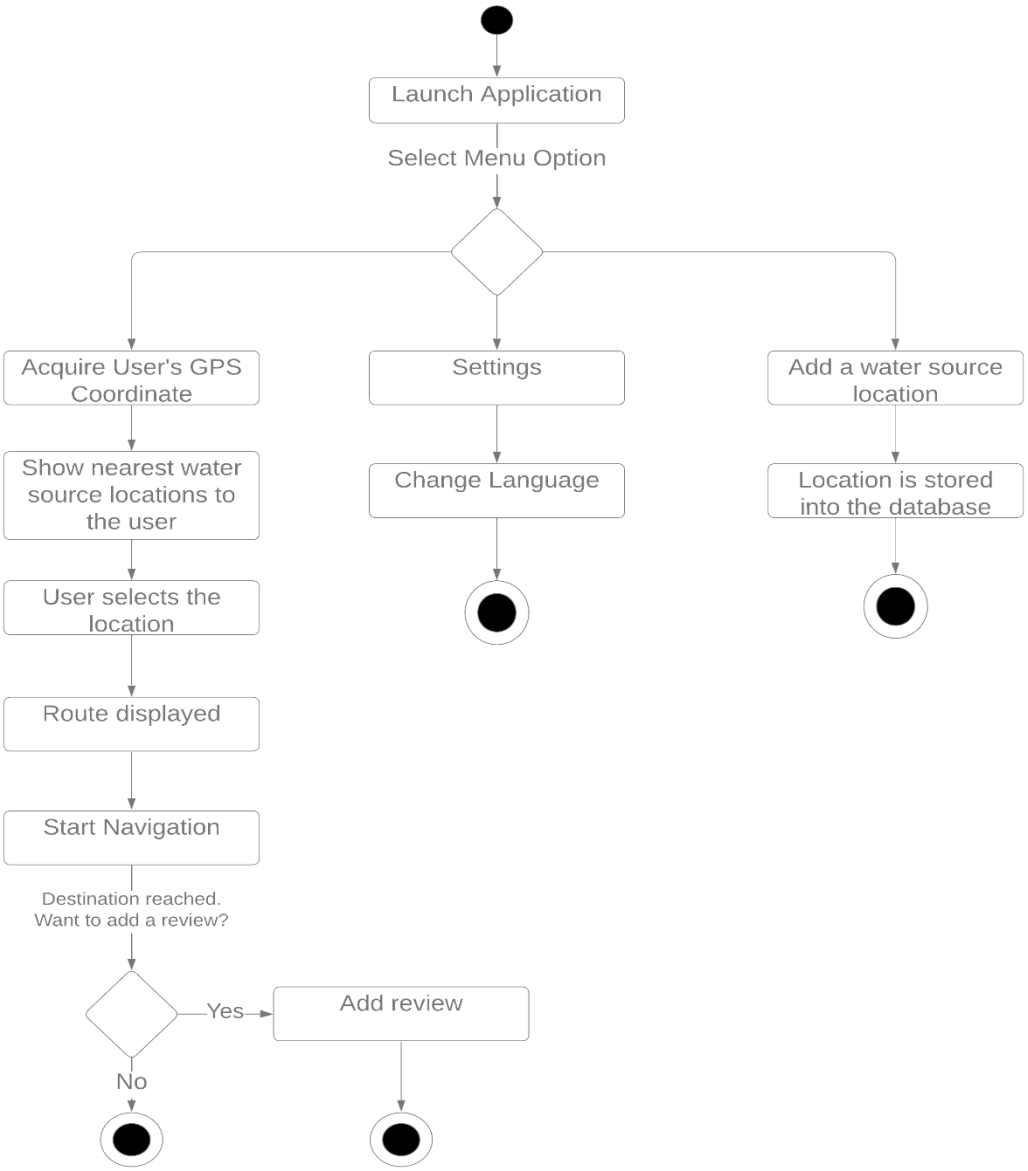

Figure 3-4 Activity Diagram for User

3.2.2.2 ACTIVITY DIAGRAM FOR ADMIN

The Activity diagram in Figure 3-5 shows that the process initiates with the launch of the admin panel, followed by a decision point where the admin faces two options. The first option involves managing resource locations, suggesting that the admin can oversee and modify information related to resource locations. The second option is to manage user feedback, indicating that the admin can handle and respond to feedback provided by users.

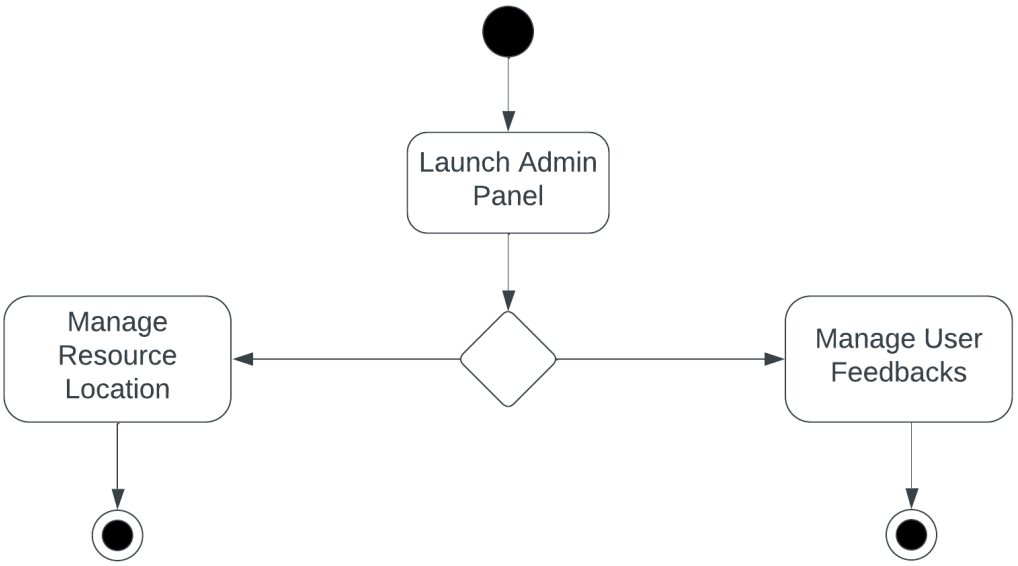

Figure 3-5 Activity Diagram for Admin

3.2.3 SEQUENCE DIAGRAM

A sequence diagram in application development is a visual representation that illustrates the interactions and flow of messages between different components, objects, or entities within a system over time. It provides a dynamic view of how various elements collaborate to achieve specific functionalities or use cases.

3.2.3.1 SEQUENCE DIAGRAM FOR USER

As seen in Figure 3-6, the user launches the application, leading to the retrieval of their location. The server then identifies the nearest water source based on this

location, and the application subsequently displays these locations on a map. Users can also participate by adding reviews or new water sources through the application. Additionally, they have the option to provide feedback about the application. All user interactions and feedback are systematically stored in a database for future reference.

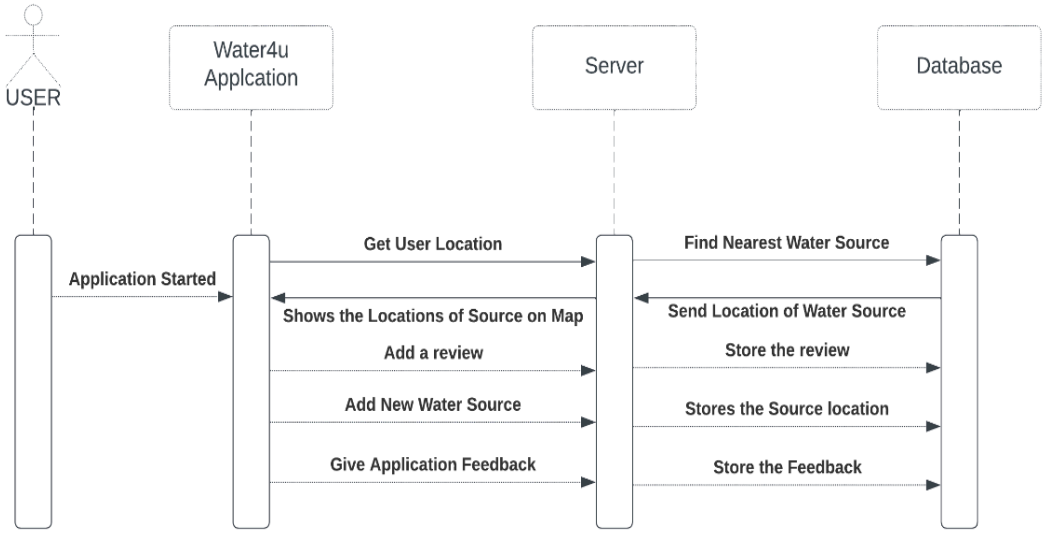

Figure 3-6 Sequence Diagram for User

3.2.3.2 Sequence Diagram for Admin

Figure 3-7 shows that after the admin launches the admin panel, it offers the capability to approve or reject pending locations. The admin panel then retrieves pending locations and feedback from the database, subsequently displaying all the information. All actions and feedback from the admin are stored in a database.

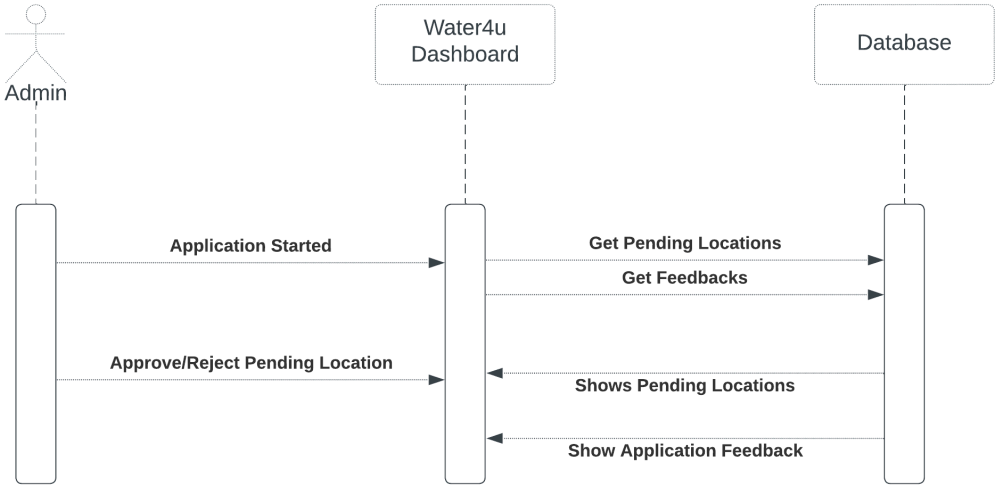

Figure 3-7 Sequence Diagram for Admin

3.2.4 ENTITY RELATIONSHIP DIAGRAM

The ERD provides an important framework for designing well-organized database structures, facilitating efficient data management, and improving understanding of user-system interactions in terms of access and reporting of water resources.

The ERD shown in Figure 3-8, encompasses three essential entities: User, representing users with geographical attributes; Water Source, capturing details about location, timing, reviews, and routes to water sources; and Report, dedicated to user-generated reports on specific water sources. Established relationships signify user interactions with water sources and the linkage of reports to particular water sources.

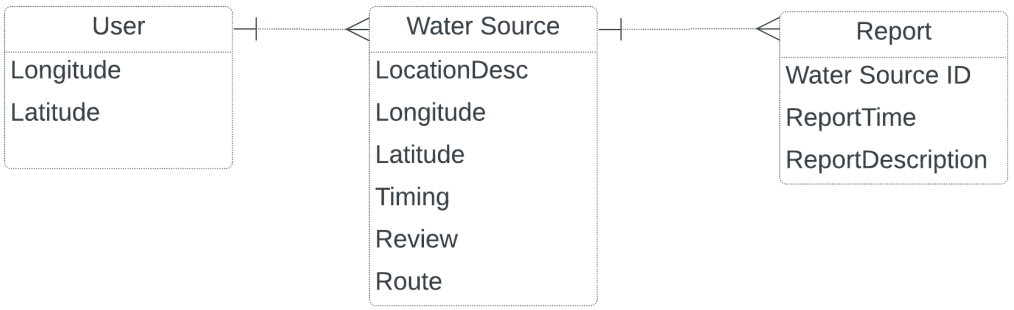

Figure 3-8 Entity Diagram

3.2.5 DATA FLOW DIAGRAM

Data Flow Diagrams help in visualizing how data moves through a system and how it is processed at various stages. They are useful for understanding system functionality, identifying data input sources, clarifying data outputs, and facilitating communication between stakeholders during the design and analysis phases of system development.

The Data Flow Diagram (DFD) in Figure 3-8, outlines the operational flow of a system. The user initiates requests for location information, which the system processes and returns. Additionally, the user can contribute to the system by inputting new source information, providing feedback, and updating the water availability status for resources. The system, in turn, manages these inputs by processing and storing the information in a database. To ensure accuracy, users can request checks on water availability, prompting the system to retrieve data from the database.

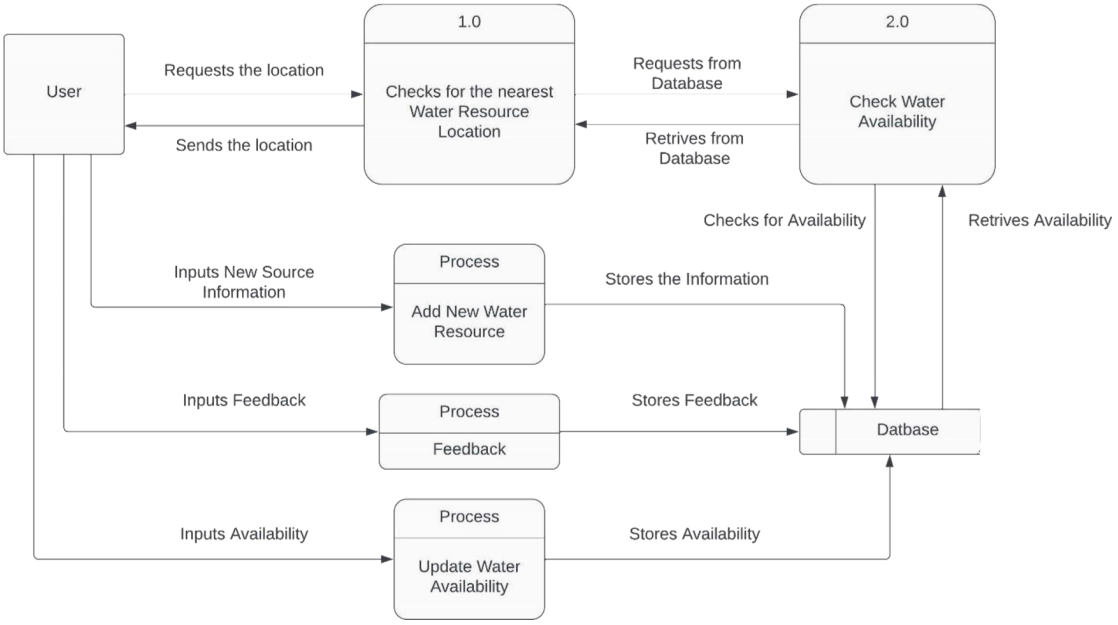

Figure 3-9 Data Flow Diagram

3.2.6 SYSTEM ARCHITECTURE

A system architecture is a conceptual model that defines the structure, behavior, and views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.

The system architecture diagram in Figure 3-9 shows that user interacts with the interface application, and their requests are transmitted to the back end through an API. Admin has direct access to the back-end, allowing them to interact with the API, server, database, and admin panel. The API serves as the intermediary between the mobile application and the back-end, handling requests from both users and admin. The server processes data, while the database stores all application-related data. The admin panel serves as a management tool for the admin.

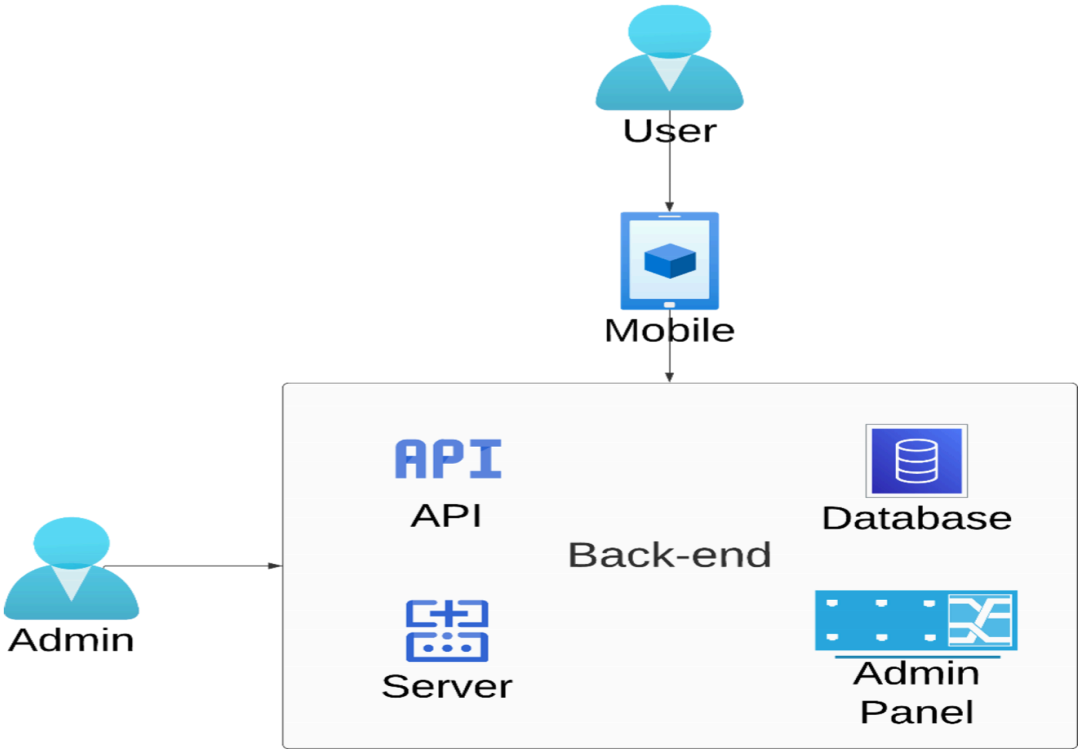

Figure 3-10 System Architecture

Chapter No. 4 TOOL & TECHNOLOGIES

4.1 OVERVIEW OF TOOLS

A software development tool is a program or application that software developers use to create, debug, maintain, or otherwise support other programs and applications. The term usually refers to relatively simple programs that can be combined to accomplish a task, much as one might use multiple hands to fix a physical object.

Application technologies encompass a broad range of tools and frameworks that facilitate the development, deployment, and maintenance of software applications. Here's an overview of some key tools that we have used in our application development

4.2 FIGMA

Figma stands out as a versatile cloud-based design and prototyping tool renowned for its collaborative features in UI/UX design. Figma is a web-based graphics editing and user interface design app. You can use it to do all kinds of graphic design work from wireframing websites, designing mobile app interfaces, prototyping designs, crafting social media posts, and everything in between.

Figma is different from other graphics editing tools. Mainly because it works directly on your browser. This means you get to access your projects and start designing from any computer or platform without having to buy multiple licenses or install software.

We leveraged Figma as our primary design tool, harnessing its collaborative features to craft the user interface (UI) for our application. Additionally, we utilized Figma's plugin functionality to streamline the integration of our UI into the Android Studio development environment. Specifically, we employed a Figma plugin to convert our design into an XML file, a format compatible with Android Studio. This efficient workflow facilitated a smooth transition from the design phase to the implementation stage, enhancing the overall development process of our application. The use of

Figma, along with its plugins, proved instrumental in achieving a visually appealing UI for our project [9].

Figure 4-1 Figma Logo

4.3 ANDROID STUDIO

Android Studio is an integrated development environment (IDE) for the creation of our Android application. Developed and maintained by Google, Android Studio is founded on the IntelliJ IDEA community edition, a well-regarded Java IDE. Boasting a Layout Editor for intuitive user interface design, Android Studio also features a robust code editor with functionalities like code completion and debugging tools. The inclusion of an Android Emulator enables developers to test applications on virtual devices, while built-in support for version control systems like Git facilitates collaboration. Instant Run allows real-time changes without a full app rebuild. The IDE's extensibility allows the integration of additional plugins, and it fully supports the JAVA programming language. Android Studio's popularity stems from its feature-rich environment, seamless integration with the Android ecosystem, and continuous updates for an enhanced development experience [10].

Android Studio played a pivotal role as the designated integrated development environment (IDE) and employing Java as our programming language, we leveraged the comprehensive features of Android Studio to streamline the development process. Bundled with the Android Software Development Kit (SDK), Android Studio provided a rich set of tools and libraries essential for crafting Android applications. The Gradle build system facilitated the automation of builds, effective dependency

management, and adaptable configurations.

Figure 4-2 Android Studio Logo

4.4 JAVA LANGUAGE

Java's object-oriented nature facilitated modular and scalable code structures, enhancing organization and maintainability. Its extensive ecosystem expedited development tasks and offered solutions to common challenges. Engaging with the Java developer community provided valuable support through forums and documentation.

Java's robust security features, scalability, and commitment to continuous updates aligned with our project's demands, ensuring a secure and reliable application. In essence, Java's strategic selection underscored its pivotal role in providing a strong foundation for our app, aligning with the objectives of our project [11].

In our project, we chose Java as the primary programming language for our Android application development. This decision was based on Java's strong presence in mobile app development and its platform independence, allowing our app to run on various devices. Operating seamlessly in Android Studio, Java provided specialized tools for efficient development.

Figure 4-3 Java Logo

4.5 FIREBASE

Firebase is a comprehensive mobile and web application development platform provided by Google. It offers a suite of tools and services designed to streamline various aspects of app development, including real-time database management, authentication, hosting, and more. Firebase is particularly popular for its ease of integration, scalability, and the ability to facilitate the development of dynamic and responsive applications.

One notable feature of Firebase is the Real-time Database, which is a cloud-hosted NoSQL database. It allows developers to store and synchronize data in real time across connected clients. This is especially beneficial for applications that require instant updates and collaboration [12].

We utilized Firebase to store locations of water sources, and feedback as a practical choice. The Real-time Database functionality enabled us to store and retrieve location data seamlessly. As locations are updated or added, the changes are instantly reflected

across all connected devices, ensuring that users have access to the most recent and accurate information.

Moreover, Firebase provides robust security rules, allowing us to control access to the database and ensuring that only authorized users can read or write data. This is crucial for maintaining the integrity and confidentiality of the stored information.

Figure 4-4 Firebase Logo

4.6 GOOGLE MAP SERVICES

Google Maps Services is a suite of APIs (Application Programming Interfaces) provided by Google, offering a wide range of services for developers to integrate dynamic mapping and location-based features into their applications. These APIs enable the creation of customized maps, geocoding, directions, and various location-based functionalities [13].

Figure 4-5 Google Maps Logo

4.6.1 GOOGLE MAPS ANDROID API

The Google Maps Android API is a powerful tool provided by Google for integrating dynamic and interactive maps into Android applications. This API enables developers to incorporate location-based services, mapping features, and various functionalities to enhance the user experience.

The integration of the Google Maps Android API emerged as a pivotal component for enhancing the user experience within our Android application. This API provides a comprehensive set of tools, including dynamic map display, markers, and interactive controls, allowing for the seamless incorporation of visually engaging mapping features. The flexibility to customize map types, draw overlays like polylines and polygons and leverage geocoding and Place Autocomplete functionalities aligns with the specific requirements of our application [14].

Moreover, the API's support for location tracking becomes particularly relevant for real-time location-based services integral to our project's objectives. The integration with Street View and other Google services further enriches the mapping capabilities, contributing to a more versatile and immersive user experience.

4.6.2 DIRECTION API

Google Maps Directions API, assumes significance as a crucial component for enhancing the navigation capabilities within our application. This API facilitates the calculation of optimal routes between specified locations, considering various transportation modes. Key features include step-by-step directions, alternative route options, and real-time traffic considerations. Access to detailed information on duration, distance, and elevation data empowers users to make informed decisions about their journeys [15].

Integrating the Direction API aligns with the primary objective of our application, which involves optimizing the user experience in terms of efficient route planning and navigation within the application. The API's ability to accommodate waypoints further enhances its utility, allowing for customized routing based on specific points

of interest.

Figure 4-6 Google Maps Platform Logo

4.7 NODE.JS

Node.js is a powerful, open-source server-side runtime environment based on Chrome's V8 JavaScript engine. Its key features include using JavaScript for both server-side and client-side scripting, an event-driven and asynchronous architecture for handling multiple connections simultaneously, fast execution, and a vast ecosystem of libraries through NPM. Node.js is known for scalability, making it suitable for applications requiring real-time features.

In the development of our admin panel, Node.js served as a robust foundation, offering an event-driven and asynchronous architecture that ensured efficient handling of concurrent tasks and responsive user interactions [16].

This choice was particularly advantageous for our application's backend operations, including the management of location-related data with Firebase.

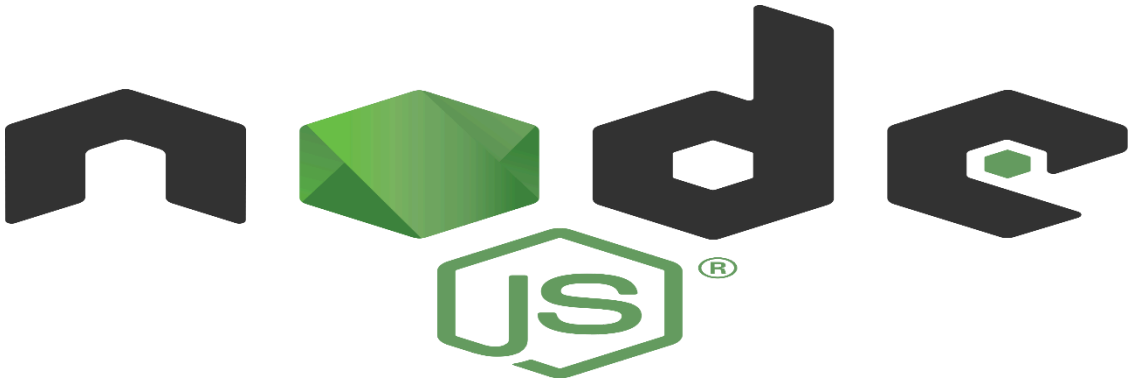

Figure 4-7 Node.js Logo

Chapter No. 5 IMPLEMENTATION

5.1 PROJECT SCREENSHOTS

The application is designed according to the inferences of Human-Computer Interaction (HCI). HCI defines a set of rules that if implemented in a project will result in a more attractive and user-friendly project. A good design is crucial to attracting new users and enabling them to make use of all the features present in a system.

Sky blue is aesthetically pleasing and commonly associated with a calming and tranquil effect. This can contribute to a positive emotional response from users, creating a pleasant interface. Sky blue is generally a high-visibility color, especially when used against contrasting backgrounds. This enhances text readability and makes interface elements more discernible, contributing to a user-friendly design. Lighter colors, like sky blue, are less likely to cause eye strain compared to bright and intense colors. This is crucial for prolonged interaction with digital interfaces, promoting user comfort.

5.1.1 SPLASH SCREEN

A splash screen, illustrated in Figure 5-1, is a brief introductory screen that appears when a software application, especially a mobile app, is launched. It serves as the initial visual encounter for the user while the application is loading. When the user first opens the 'Water4u' application, they will be greeted by the splash screen, offering a preview of the application's logo and name title in both English and Urdu as basic files load.

Figure 5-1 Splash Screen

5.1.2 MAIN SCREEN

Once the application completes its loading phase, the Splash Screen transitions to the main user interface as shown in Figure 5-2, presenting four visible buttons:

- Direction
- Settings
- Add Source
- Feedback

Each of these buttons, when clicked, navigates the user to distinct sections within the application.

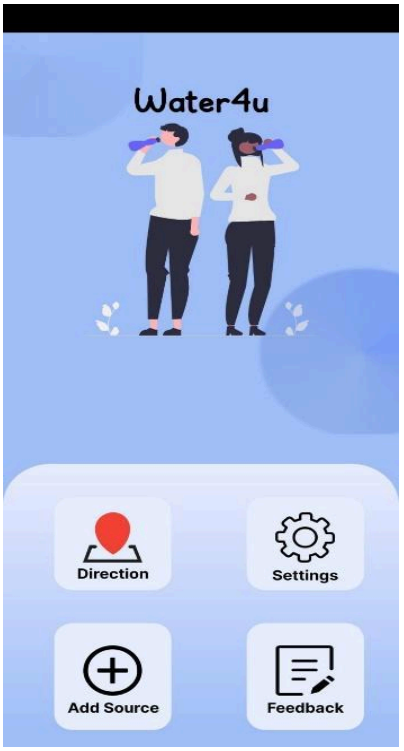

Figure 5-2 Water4u Main Screen

5.1.3 DIRECTION SCREEN

Upon selecting the 'Direction' button from the main screen (Figure 5-2), the user is moved into a dynamic map interface (Figure 5-3) that pinpoints to their current location and displays the nearest clean water sources in their immediate surroundings.

Once the user chooses their desired destination, the map displays the route to that location, enabling the user to navigate effectively as shown in Figure 5-4.

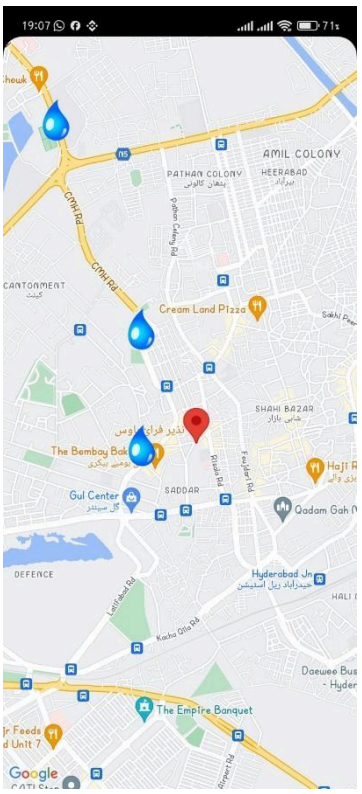

Figure 5-3 Resource Selection Map

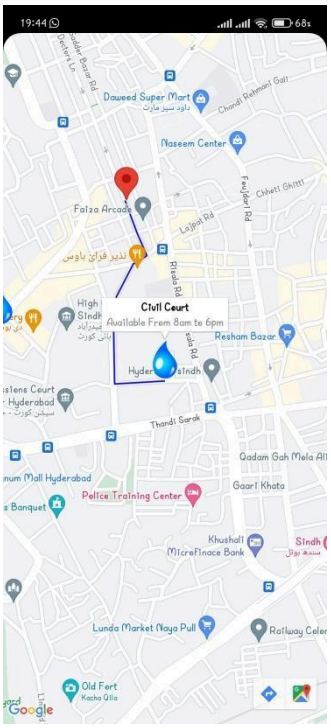

Figure 5-4 Route to the source

5.1.4 SETTINGS SCREEN

Upon clicking the settings button on the main screen (Figure 5-2), the screen transitions to a language customization interface, enabling the user to switch between English and Urdu language.

Figure 5-5 Setting Screen

5.1.5 ADD SOURCE SCREEN

When a user selects the "Add Source" button on the main screen (Figure 5-2), the screen shifts to a map interface (Figure 5-5), allowing the user to mark the desired location of a water source. Subsequently, a form appears, prompting the user to provide details about the water source they wish to add as shown in Figure 5-6, thereby facilitating a user-friendly and interactive process for contributing information, which is stored in the database for approval.

Figure 5-6 Map

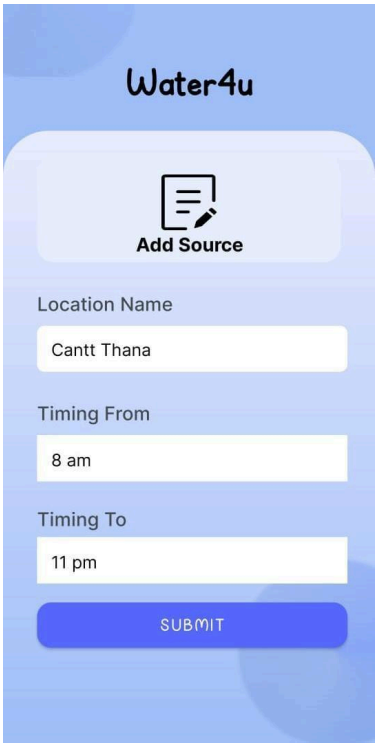

Figure 5-7 Form to add a new water source

5.1.6 FEEDBACK SCREEN

The user can select the "Feedback" button, among the four available buttons on the main screen, which allows the user to provide valuable feedback for the application in a form shown in Figure 5-7. This feedback is then stored in the database and can be utilized for future enhancements and improvements.

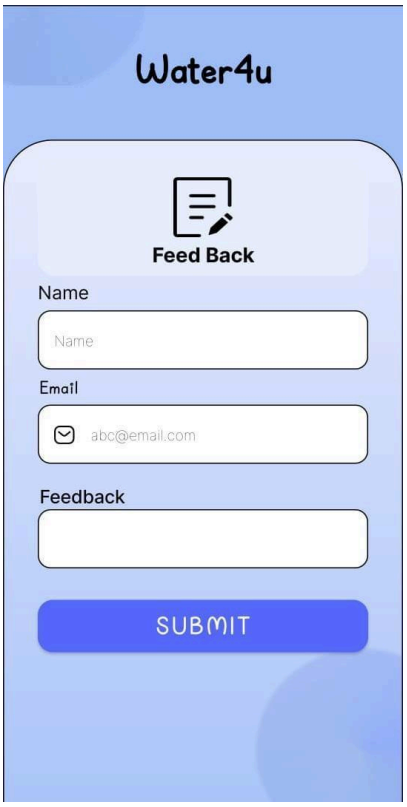

Figure 5-8 Feedback Screen

5.2 INTEGRATION OF FIREBASE

5.2.1 FIREBASE INTEGRATION WITH APPLICATION

To incorporate Firebase services, start by connecting Firebase to the project using the SDK. Visit the Firebase website, sign in or create an account, and access the console for projects. Click 'add a new project' to initiate a Firebase project, including steps like naming the project and opting for Google Analytics.

After project creation, connect it to the app by specifying the app type (e.g., Android). Provide necessary details like the package name, app nickname, and debug signing certificate. Download and place the generated google-services.json file in your Android app.

Add the Firebase SDK to your app, making necessary adjustments in the app's settings for effective communication with the Firebase project. The home page will then resemble Figure 5-8.

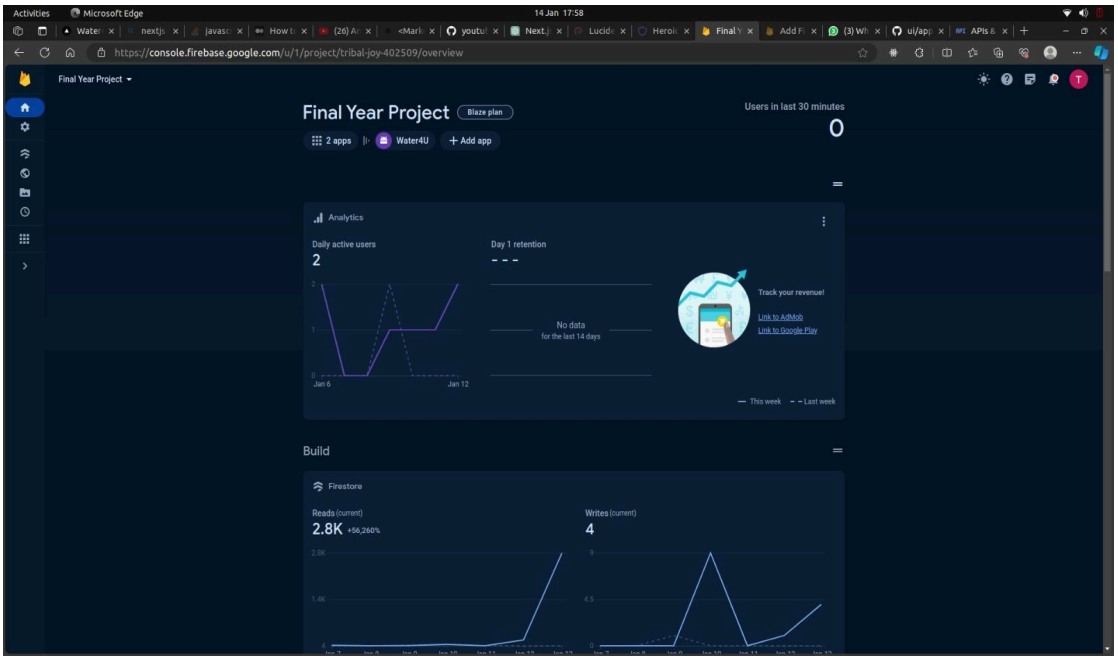

Figure 5-9 Firebase Home Page

5.2.2 FIREBASE INTEGRATION IN THE ADMIN PANEL

Integrating Firebase with a web application involves creating a Firebase project, registering the web app, obtaining Firebase configuration, including the Firebase SDK in your HTML, initializing Firebase in your JavaScript code, and using various

Firebase services as shown in Figure 5-9.

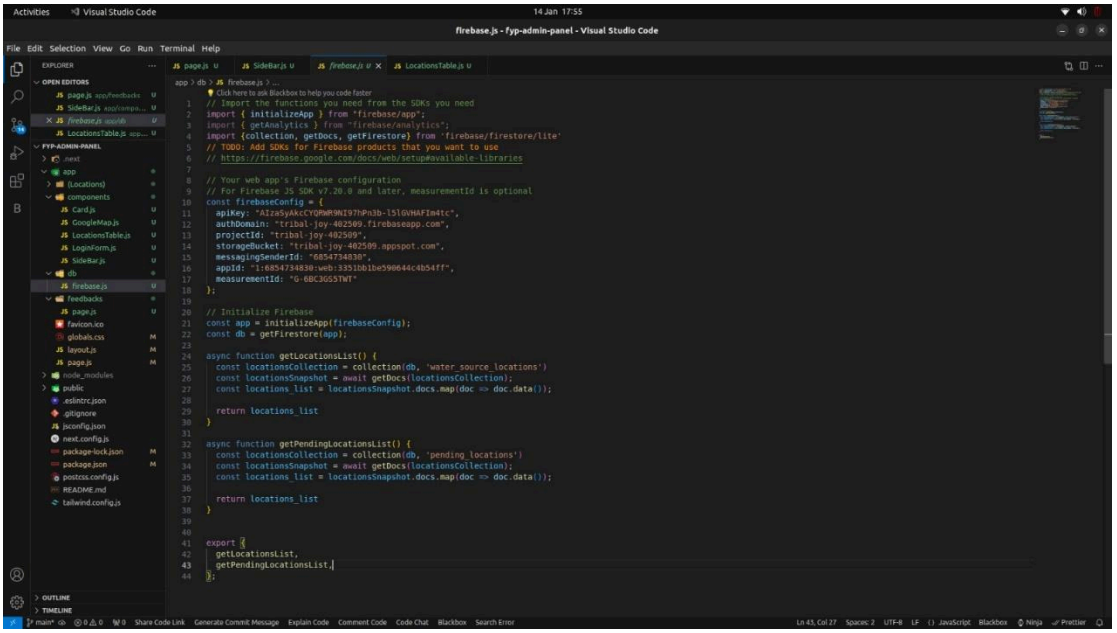

Figure 5-10 Firebase Integration in Admin Panel Code

5.2.3 CONFIGURING CLOUD FIRESTORE

Figure 5-10 shows that the Firestore database service is organized within a class placed in a distinct file in the services directory. This specific file is dedicated to offering the features delivered by the Cloud Firestore package. It handles all the operations related to Creating, Reading, Updating, and Deleting (CRUD) data. Whenever any file needs to interact with the database for any CRUD operation, it employs an instance of the database class to execute the action as outlined in its class definition.

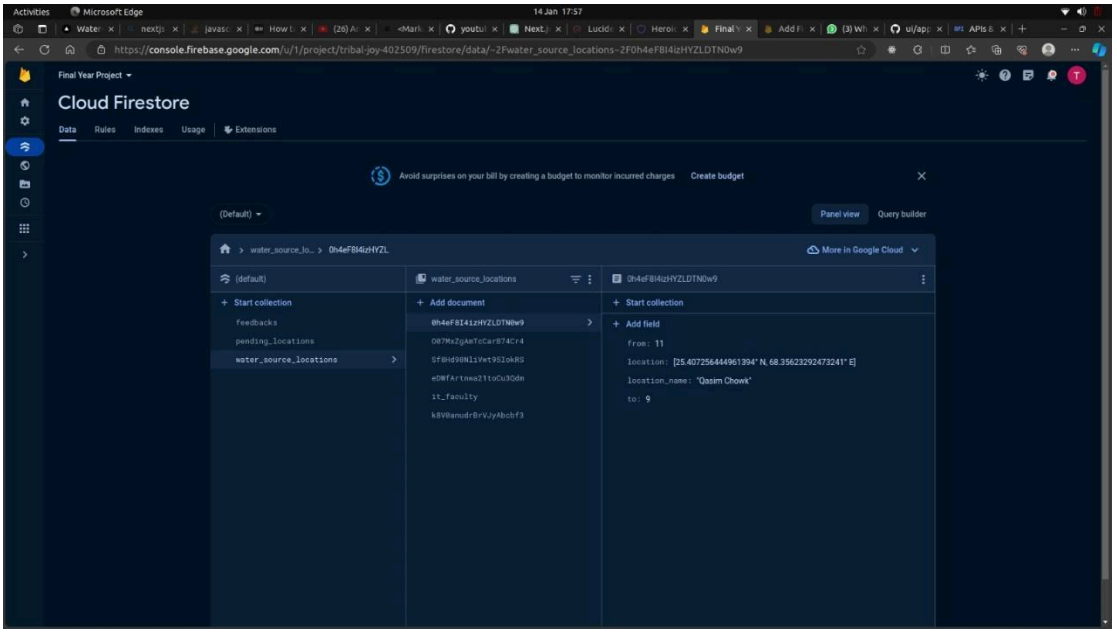

Figure 5-11 Firestore Configuration

5.2.4 MANAGING DATA IN FIREBASE VIA REST API

The communication with the Firebase Cloud Firestore involves making requests through a REST API implemented in Node JS. All the functions responsible for interacting with collections in the Firestore database utilize this REST API. For instance, when a user adds a new location, review, or feedback, the information is stored in the collection. Similarly, administrative tasks such as deleting a location or updating its details are executed using delete operations by the admin.

5.3 ADMIN PANEL

An admin panel, short for an administration panel, is a web-based interface or a dashboard that allows admins or authorized personnel to manage and control a system, application, or website. The admin panel provides access to various tools and features that enable administrators to perform tasks

5.3.1 ADMIN LOGIN

We have implemented an admin panel login mechanism (Figure 5-11), ensuring data security and restricting unauthorized access. The incorporation of this login feature adds a layer of protection, preventing unauthorized individuals from gaining entry and maintaining the confidentiality and integrity of the data.

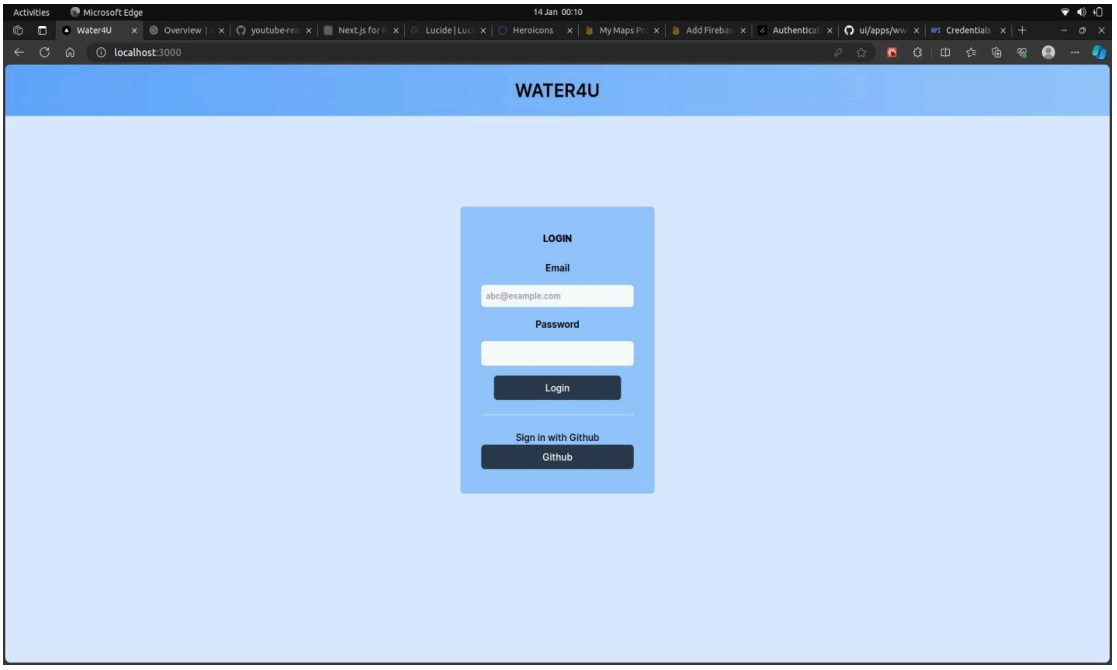

Figure 5-12 Admin Login Page

5.3.2 DASHBOARD

The admin panel dashboard (Figure 5-12), provides an insightful overview, displaying real-time information on current active users, the total number of added locations on the map, and pending location submissions along.

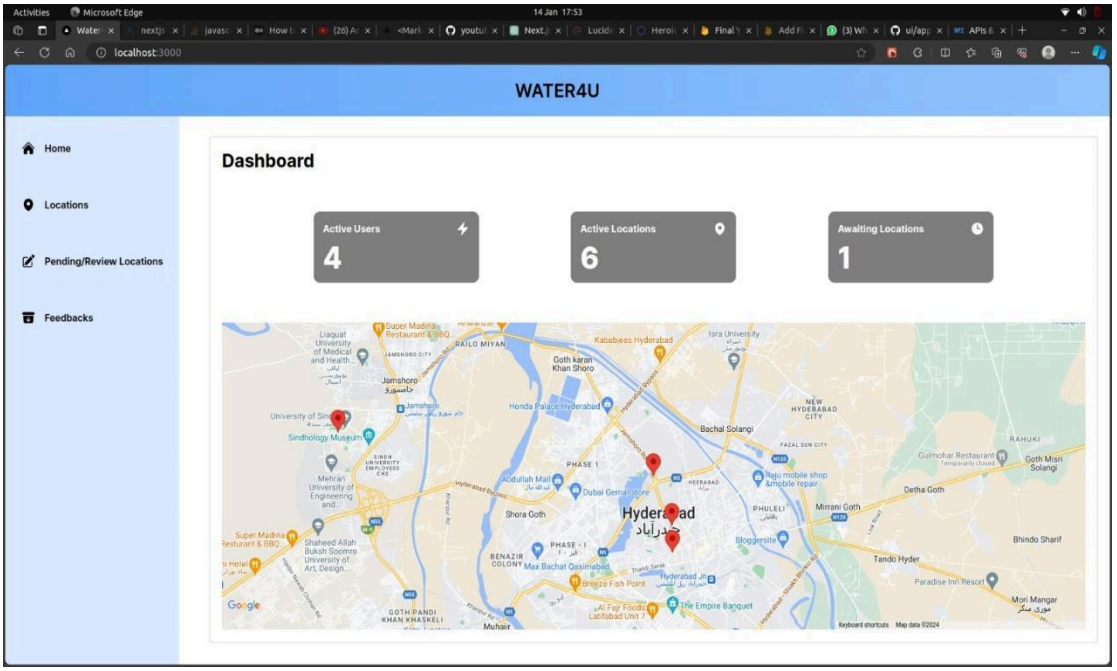

Figure 5-13 Admin Dashboard

5.3.3 LOCATIONS

The active location menu (Figure 5-13), opens up a table format that presents essential details about the available locations on the map. The table includes information such as the name of the location, longitude, latitude, the operational timeframe of the water source, and user reviews.

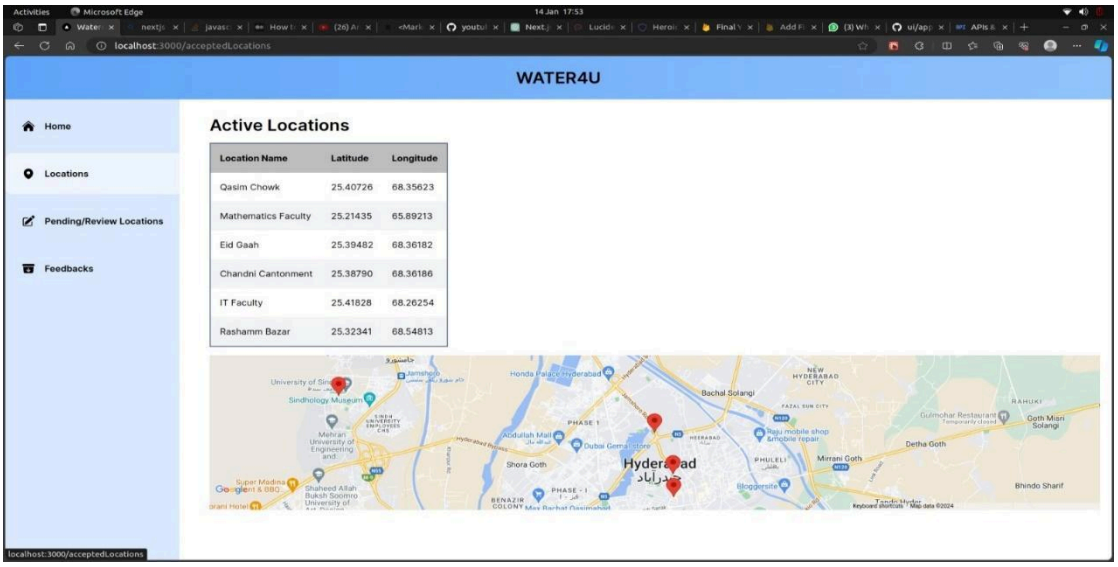

Figure 5-14 Active Locations Page

5.3.4 AWAITING LOCATIONS

The awaiting location menu (Figure 5-14), is designed to showcase a table representation of locations added by users through the "Add Source" button in the application. The admin, can review these pending locations and make informed decisions by either approving or denying their inclusion on the map.

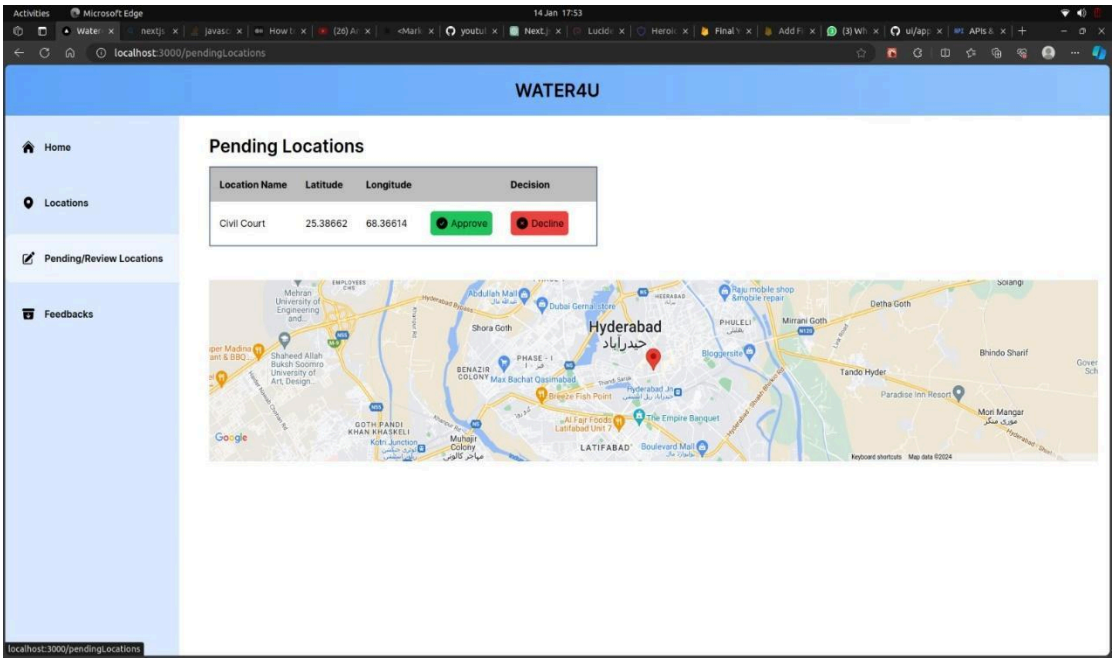

Figure 5-15 Awaiting Locations Page

5.3.5 FEEDBACK

The feedback page in the admin panel (Figure 5-15), works as a dedicated space to present and manage user feedback concerning the application. These feedbacks from the users can be used as a building block to make the application better and more user-centric.

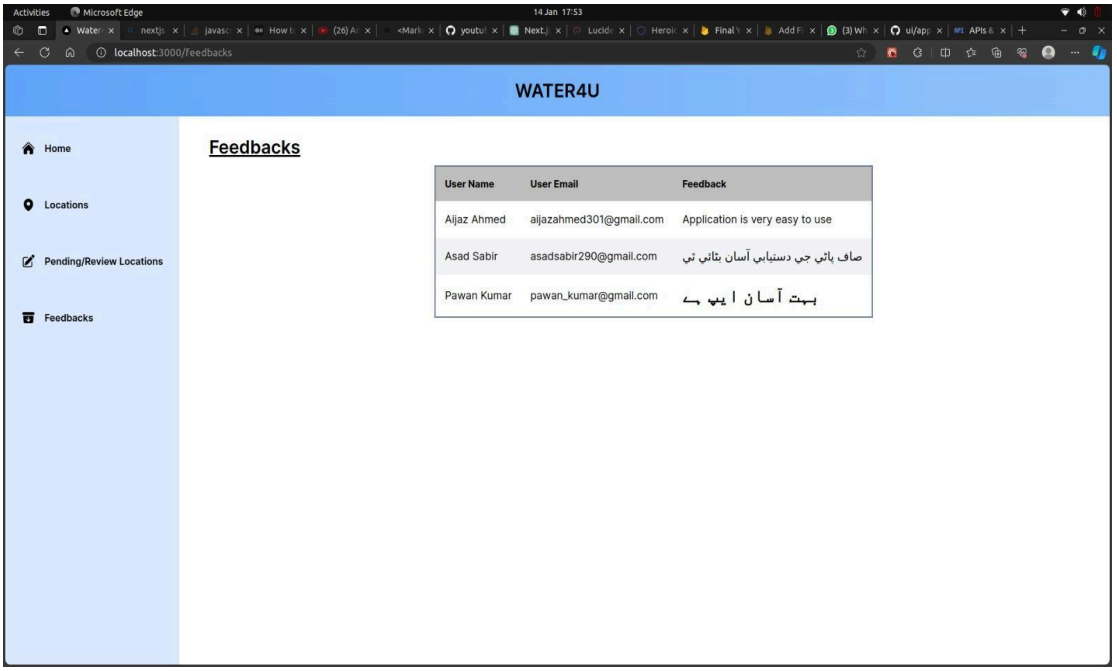

Figure 5-16 Application Feedback Page

Chapter No. 6 RESULTS AND CONCLUSION

6.1 RESULT

Water4u emerges as a beacon of hope, highlighting how crowd-sourced, real-time information can effectively address water challenges. The evident positive user engagement and its impact on understanding and decision-making affirm the transformative potential of such applications.

As our project concludes, we recognize the dynamic nature of water-related challenges and advocate for sustained innovation. There is a clear need for adaptive, region-specific solutions, and Water4u, with its real-time information model, stands out as a promising avenue for future exploration and refinement. It signifies a potential shift in addressing water challenges through community-driven data.

6.2 CONCLUSION

As we conclude this exploration into the realm of mobile applications for improving access to clean water, the journey has been both enlightening and impactful. Navigating through the functionalities of mWater, Akvo Flow, and TaroWorks has revealed their global influence, touching lives in over 180 countries. The emphasis on usability, as highlighted in the literature review, has underlined the significance of creating apps that are not only efficient but also enjoyable to use.

The integration of Water4u into our discourse brings forth a promising solution, particularly in the context of Pakistan, by providing real-time information on clean water sources through crowd-sourcing. Witnessing technology tailored to specific regional challenges opens up exciting possibilities for more inclusive solutions. However, this marks just the beginning, and there's an evident need for continuous innovation to meet evolving challenges.

6.3 FUTURE RECOMMENDATION

Looking ahead, the future presents opportunities for further enhance our application with innovation and more creativity:

- Enhanced Data Accuracy and Quality:
    - Future developments can focus on refining crowd-sourced data models, ensuring the accuracy and quality of information provided by the application.
- Community Engagement and Education:
    - Implementing features within applications that promote community engagement and education can contribute to sustainable water practices and empower users to actively participate in water management along with information regarding water diseases.
- Integration of Emerging Technologies:
    - Exploring the integration of emerging technologies such as artificial intelligence and machine learning can add predictive and analytical capabilities, improving the applications' overall functionality.
- Localization and Cultural Sensitivity:
    - Tailoring applications to the local context and ensuring cultural sensitivity in design and functionality will enhance user adoption and effectiveness, especially in diverse regions.
- Collaborative Partnerships:
    - Encouraging teamwork between developers, government agencies, non-profit organizations, and local communities can help take a well-rounded approach to managing water. By bringing together everyone's knowledge and resources, we can find better solutions for water-related issues.

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