**HYDROCHECK: Water Leak Reporting and Alert App**

**A SOFTWARE PROJECT PRESENTED TO THE FACULTY OF**

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**DR. EMILIO B. ESPINOSA SR. MEMORIAL**

**STATE COLLEGE OF AGRICULTURE AND TECHNOLOGY**

[**www.debesmscat.edu.ph**](http://www.debesmscat.edu.ph/)

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**PRECY R. ADORICO**

**ANGELINE L. ALAHID**

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**TABLE OF CONTENTS**

**Description Page**

TITLE PAGE . . . . . . . . . i

APPROVAL SHEET . . . . . . . . ii

ACKNOWLEDGMENT . . . . . . . iii

EXECUTIVE SUMMARY . . . . . . . iv

TABLE OF CONTENTS . . . . . . . vi

LIST OF FIGURES . . . . . . . . vii

LIST OF TABLES . . . . . . . x

LIST OF APPENDICES . . . . . . . xi

**Chapter I – Introduction**

Project Context . . . . . . . . 1

Purpose and Description . . . . . . . 6

Objectives . . . . . . . . . 10

Scope and Limitations . . . . . . . 11

Definition of Terms . . . . . . . . 12

**Introduction**

**Project Context**

Water remains one of the most essential resources for sustaining life, playing a critical role in human health, agriculture, sanitation, and industrial activities. However, despite its significance, the issue of water wastage especially through undetected leaks continues to pose serious challenges globally. Leaks in pipelines, outdated infrastructure, and inefficient monitoring methods contribute significantly to the depletion of this vital resource, causing not only environmental degradation but also economic losses and health hazards. Water leak detection is a challenge faced by both developed and developing nations.

In urban areas of the United States and Europe, water utilities have adopted smart metering systems and predictive maintenance tools. For instance, the American Water Works Association (2020) emphasized that U.S. municipalities lose about 14–18% of their treated water to leaks. Similarly, studies in European countries such as Germany and the UK have explored the use of acoustic sensors and AI-based predictive tools, but these solutions often come with high implementation costs and complex maintenance.

In Southeast Asia, countries like Malaysia and Indonesia face increasing challenges in maintaining water infrastructure. According to a 2019 study by the Asian Development Bank, non-revenue water due to leaks and illegal connections exceeds 30% in several ASEAN nations. The Philippines is not exempt from this issue.

The Metropolitan Waterworks and Sewerage System (MWSS) reported in 2021 that Metro Manila alone experiences significant water loss, primarily due to undetected leaks. While large-scale urban systems may have the capacity to implement high-tech solutions, many provincial municipalities and barangays rely on manual inspection and community reports. At the municipal level, some local governments in the Philippines have initiated community-based programs to address minor water infrastructure problems. For instance, a municipal pilot project in San Mateo, Rizal (2022) leveraged Facebook groups and SMS reporting for residents to notify water authorities of pipe leaks. On the barangay level, Barangay San Isidro in Makati implemented a barangay hotline and community bulletin in 2021 to manage water-related complaints. Water loss through undetected or unaddressed leaks remains one of the most persistent challenges in urban and rural water management worldwide.

A study conducted by the World Bank (2020) estimates that approximately 25–30% of treated water is lost globally due to leaks and infrastructure inefficiencies. In Southeast Asia, countries like Thailand and Vietnam have initiated national-level leak reduction programs, integrating both sensor-based systems and public reporting platforms to mitigate water wastage (Asian Development Bank, 2021). Similarly, the Philippine Water Works Association (PWWA) has underscored the need for localized interventions tailored to urban and rural settings where access to advanced leak-detection technology is limited.

At the regional level, the Metropolitan Waterworks and Sewerage System (MWSS) in Metro Manila has developed monitoring and response protocols to track pipeline damage, but challenges remain in response time and public engagement (MWSS Annual Report, 2022).

Municipalities such as Santa Rosa, Laguna, have introduced community watch initiatives that allow residents to report infrastructure concerns, including water-related issues, but these remain largely informal and undocumented. On the barangay level, limited resources and the absence of structured platforms make it difficult to address even minor leaks promptly, which can escalate into serious water loss and health hazards. Existing literature and case studies highlight that public participation, when effectively harnessed, can significantly complement traditional water monitoring systems. Studies from community-led projects in Kerala, India, and Medellín, Colombia, demonstrate the success of using mobile-based applications to facilitate citizen reports of local utility issues (UN Habitat, 2021). These efforts emphasize the need for inclusive and low-cost digital tools that bridge the gap between service providers and communities.

Although these efforts reflect a growing awareness of participatory governance, they remain fragmented and lack an integrated digital reporting and management system. Given the increasing need for more accessible, reliable, and scalable water leak reporting tools, this project proposes the development of a digital solution that leverages citizen participation and real-time communication between users and water service providers. This approach will be critical in communities where advanced IoT-based monitoring systems are financially or logistically infeasible.

This initiative introduces a community-centered application aimed at simplifying the process of reporting water leaks. Unlike sensor-reliant systems, the proposed solution is built upon active community involvement, empowering users to submit real-time data including location, descriptions, and images of water leaks. These reports are instantly communicated to the respective municipal offices, enabling timely intervention and efficient resource management. Through this system, users will not only contribute to mitigating water waste but will also become key stakeholders in infrastructure maintenance and environmental conservation. Municipal authorities, in turn, benefit from a reliable database of leak reports which can be used for analysis, trend monitoring, and strategic planning. By addressing water leak issues at the grassroots level, the project aligns with sustainable development goals related to water security and community resilience.

The importance of this study lies in its potential to enhance public participation in addressing water-related problems, improve municipal response mechanisms, and reduce water losses significantly. By creating a structured platform for leak reporting, the initiative will support better communication between citizens and local government units, increase transparency, and promote environmental accountability. Municipalities and utility companies have attempted to implement solutions such as scheduled maintenance, infrastructure upgrades, and smart water metering systems. While these efforts have been helpful, they are often limited in reach due to budget constraints, lack of personnel, and the complexity of implementing new technologies across entire communities. In many areas, especially in developing countries or less urbanized regions, water infrastructure remains outdated, making proactive leak detection even more difficult.

To address these challenges, digital technology has emerged as a powerful tool in water management. The rise of mobile applications, cloud computing, and real-time data monitoring has made it possible to develop innovative solutions for leak detection and water conservation. However, many existing smart water management systems depend on expensive IoT (Internet of Things) sensors and automated detection technologies that require extensive installation and maintenance. These solutions, while effective, are not always feasible for widespread adoption, particularly in resource-limited communities.

Recognizing the need for a practical and accessible alternative, this project introduces this Application. Unlike automated leak detection systems, this invention relies on active user participation to report leaks as they occur. This community-driven approach not only ensures that leaks are detected in real time but also fosters a sense of responsibility and awareness among residents. The app serves as a digital platform where users can quickly report leaks by submitting location details, descriptions, and supporting images. Upon submission, municipal water service providers receive instant notifications, allowing them to prioritize and address issues efficiently.

This application is designed to bridge the gap between citizens and municipal authorities by providing an intuitive, user-friendly interface for leak reporting and management. The app empowers residents to take action when they notice water leaks, reducing the time it takes for authorities to respond and ultimately preventing unnecessary water wastage. Additionally, it serves as a valuable data collection tool, enabling municipalities to analyze trends, track recurring issues, and make informed decisions about infrastructure improvements.

Water conservation is a shared responsibility that requires the active involvement of both authorities and citizens. By leveraging digital technology and community participation, this study aims to create a sustainable, long-term solution for leak management. Through early detection and prompt reporting, this project contributes to water conservation efforts, reduces financial burdens on property owners, and helps municipalities optimize their resources for infrastructure maintenance and repair.

Furthermore, this initiative encourages individuals to take a proactive role in safeguarding their water supply. It raises awareness about the impact of water wastage, promotes responsible water usage, and cultivates a sense of accountability within communities. When citizens are given the power to report and track leaks, they become active stakeholders in the preservation of this essential resource. Additionally, study invention contributes to reducing the strain on local water distribution systems by ensuring that leaks are addressed before they escalate into major water losses. It also minimizes risks associated with waterborne diseases caused by stagnant water from leaks and broken pipelines. In commercial and industrial settings, this tool helps businesses comply with environmental regulations, ensuring that water conservation remains a priority in both public and private sectors. Another key consideration is the app’s potential impact on disaster preparedness and resilience. Water leaks, if not addressed promptly, can weaken infrastructure and contribute to flooding in urban areas. This application can serve as an early warning system by enabling residents to report leaks that could lead to larger structural problems. In the long term, this proactive approach can help prevent infrastructure failures and support disaster risk reduction efforts.

Also, the important aspect of this water leak reporting and alert app is its potential application in disaster risk management. Water leaks, if ignored, can lead to severe damage such as road collapses, flooding, and contamination of clean water supplies. By enabling citizens to report issues as soon as they arise, the app contributes to early warning systems and helps municipalities prevent major infrastructure failures. Additionally, by ensuring quick action on reported leaks, this application reduces the risks of waterborne diseases caused by stagnant water and contamination. With increasing concerns over climate change and water scarcity, innovative and cost-effective solutions like this application are essential. By harnessing the power of digital technology and citizen engagement, this project seeks to revolutionize how water leaks are reported and managed. Ultimately, this app aims to create a more efficient, responsive, and environmentally conscious approach to water leak detection and repair, contributing to long-term sustainability and better resource management.

The importance of this study lies in its potential to enhance public participation in addressing water-related problems, improve municipal response mechanisms, and reduce water losses significantly. By creating a structured platform for leak reporting, the initiative will support better communication between citizens and local government units, increase transparency, and promote environmental accountability.

**Purpose and Description**

The primary purpose of this project is to develop a responsive and practical platform designed to improve the detection, reporting, and resolution of water leaks in residential and public areas. Rather than utilizing expensive infrastructure or automated sensors, this platform promotes a community-based approach by equipping users with a mobile and web-based application for submitting reports. The application will enable users to attach location data, textual descriptions, and photographic evidence of water leaks. Reports will be automatically routed to relevant municipal departments, facilitating faster action and reducing downtime in addressing water issues. Furthermore, the system will store submitted data securely on a cloud-based server, ensuring easy access for future reference, audit, and policy formulation.

From an administrative perspective, the application will include a management dashboard for tracking reports, validating submissions, assigning repair tasks, and analyzing recurring issues. This helps streamline repair operations and enhances the decision-making process by providing statistical insights. By combining technology with active citizen engagement, the proposed system aims to reduce water wastage, minimize public health risks associated with stagnant water, and foster a culture of transparency and accountability in local governance. It positions itself as a cost-effective and scalable alternative for municipalities looking to modernize their water leak response frameworks without incurring the costs of automated detection networks. By implementing this app, the project seeks to revolutionize how communities handle water leaks. This system provides an efficient, cost-effective, and highly scalable solution for leak detection and reporting. Instead of waiting for authorities to detect leaks through scheduled inspections or expensive monitoring equipment, HYDROCHECK places the power in the hands of the people who experience these issues firsthand.

Furthermore, the app has the potential to improve municipal infrastructure management by offering valuable insights into leak patterns and high-risk areas. With a well-documented database of reported leaks, authorities can prioritize repairs, allocate resources more efficiently, and prevent further damage before leaks escalate into major problems. The long-term goal of this app is to encourage responsible water usage, reduce unnecessary wastage, and ensure that communities have access to safe and sustainable water resources. By fostering a culture of awareness and collaboration, this project contributes to global water conservation efforts and helps build a future where every drop of water is used efficiently and responsibly.

This app is more than just a mobile application is a step toward a smarter, more sustainable approach to water management. Through active community participation and digital innovation, this project aims to create lasting change, ensuring that water leaks are no longer overlooked but are instead addressed promptly and effectively.

**Objectives**

The primary objective of this project is to design and implement a user-driven water leak reporting and alert system that empowers both citizens and municipal authorities to collaborate in addressing water infrastructure issues. The system will serve as a centralized digital platform for manual leak reporting, ensuring timely responses and contributing to efficient water resource management. This proposal aims to develop a responsive, secure, and community-oriented solution with the following specific object:

1. Reporting and Monitoring Features

Provide a user-friendly dashboard where residents can manually report water leaks using descriptive text, images, and location-based tagging.

Enable real-time updates on the status of submitted reports, offering transparency to users about the progress of resolution efforts.

Allow municipal staff to validate, categorize, and assign repair teams to reported issues efficiently.

Store submitted reports securely on a cloud platform for easy access, monitoring, and tracking of recurring leak areas.

2. System Model and Management Tools

Develop a role-based admin panel where authorized municipal personnel can manage incoming reports, monitor response times, and identify critical areas based on frequency and severity.

Generate visual and statistical data analytics that provide insights into leak trends, reporting frequency, and the efficiency of interventions.

Include notification systems that send alerts to local users about reported leaks near their area and notify designated authorities for immediate response.

Offer a scalable architecture that can support future integration of advanced features like automated diagnostics and third-party mapping services.

3. Quality and Standards Compliance (Based on ISO/IEC 25010)

The system will adhere to the ISO/IEC 25010 quality model, focusing on the following attributes:

Functional Suitability: Ensure the application effectively supports reporting, tracking, and administrative functions as intended by its users.

Reliability: Guarantee system stability and consistent performance, especially in handling multiple simultaneous reports.

Usability: Prioritize intuitive user interfaces that accommodate users of varying technical literacy levels.

Security: Protect user information through secure login, encrypted data transfer, and role-based access controls.

Maintainability: Use modular development practices to simplify future updates and improvements.

Portability: Optimize the application for access across multiple devices and browsers, with seamless responsiveness on both web and mobile platforms.

This initiative promotes civic engagement, improves leak resolution timelines, and contributes to sustainable water resource management. Through a community-based manual reporting approach, the system empowers users to become proactive participants in maintaining public utilities, even without the use of complex sensors or IoT technology**.**

**Scope**

This software project is centered on the development of a web and mobile application designed to enable residents and users within a specific community or municipality to report and track water leaks. The system will serve as a centralized platform where users can manually submit reports of detected leaks in their surroundings, such as on public roads, pipelines, or residential areas.

The application will support features including user registration, report submission with optional images and location details, status tracking of reported issues, and notifications or alerts once a report has been acknowledged or resolved by the authorities. A separate interface will be provided for municipal officials or water system administrators to view, manage, and act on submitted reports. Initially, the system will be piloted in a limited geographic area to assess functionality, gather feedback, and make improvements before broader deployment. While this phase does not include the use of IoT or automated sensor technology, the system is designed with flexibility for future integration of such tools to enhance efficiency. The project emphasizes simplicity and accessibility, encouraging community participation and awareness around water conservation and infrastructure maintenance.

**Limitations**

The current version of the application will operate solely through manual user input. It does not include automated or sensor-based leak detection systems, which may limit the ability to detect underground or otherwise hidden leaks without visible signs. As a result, the system’s performance will rely heavily on the active participation of the community in reporting issues.

In areas with limited internet connectivity or low digital literacy, the adoption and effectiveness of the platform may face challenges. Furthermore, response times to reported issues will depend on the coordination and resources of the local municipal authorities, which may vary from one locality to another.

The system is also limited to leak reporting and alert notifications and does not encompass broader water management features such as billing, consumption tracking, or pipeline diagnostics. It is intended as a practical and scalable reporting tool, with future enhancements planned based on user feedback and technological capacity.

**Definition of Terms**

The following terms are defined basically by simplicity and a common understanding of the project**:**

**Leak Detection:** The process of identifying unintended water loss due to broken pipes, faulty plumbing, or infrastructure damage through user reports.

**Reporting System:** A digital platform that allows users to submit and track reports of water leaks and related issues.

**Real-Time Notification:** Instant alerts sent to users or municipal authorities regarding reported water-related issues to ensure prompt response and resolution.

**Dashboard:** A centralized interface that allows users and municipal staff to monitor reported leaks, track responses, and oversee maintenance activities efficiently.

**Cloud-Based Storage:** A secure and scalable digital solution for storing, managing, and retrieving water leak report data and system records remotely.

**Municipal Water Services:** Government or private entities responsible for maintaining and managing water distribution, leak repairs, and infrastructure improvements.

**Push Notification:** An automated message sent to users and municipal staff to inform them about new reports, status updates, and urgent water-related alerts.

**Infrastructure Management:** The structured administration, repair, and enhancement of water supply systems to ensure sustainability and efficiency in water distribution.

**User-Driven System:** A system that depends on users actively reporting water leaks rather than relying on automated sensors or AI-based detection methods.

**Community Engagement:** The active involvement of citizens in identifying and reporting leaks, ensuring that the system is effective in addressing local water concerns.

**Mobile Application:** A smartphone-based software designed to allow users to report, track, and receive updates on water leaks conveniently.

**Incident Tracking:** A feature that enables users to follow the progress of their reported leaks, from submission to resolution, ensuring transparency in the process.

**Geolocation Tagging:** The ability of the app to capture and attach the exact location of reported leaks, making it easier for repair teams to locate and fix the issue.

**User Authentication:** A security feature that ensures only registered users can submit reports, preventing spam or inaccurate leak reports from affecting the system.

**Data Encryption:** A security measure implemented to protect user information and prevent unauthorized access to sensitive data stored in the system.

**System Reliability:** The ability of the application to function consistently and accurately in receiving reports, sending notifications, and maintaining data integrity.

**Pilot Testing:** The initial phase of implementation where the app is tested in a specific community to evaluate its effectiveness before a broader launch.

**Water Conservation:** The practice of using water efficiently to reduce unnecessary waste and promote sustainable water management within communities.

**Maintenance Request System:** A feature in the app that allows users to request follow-ups on unresolved leak reports, ensuring continued attention to serious water issues.

**Automated Report Logging:** The system’s ability to systematically store and organize user-submitted reports, enabling easy retrieval and analysis of water leak incidents.

**Chapter III**

**Methodology**

This chapter outlines the methodology for the development of "**Hydro Check: Water Leak Reporting and Alert App**," focusing on the processes and strategies adopted to create an effective, scalable, and reliable system. The development process utilized various software tools, programming languages, and modeling techniques, ensuring a smooth, user-centric design that addresses the critical issue of water leak detection and reporting.

**Project Design**

The software project, "**Hydro Check: Water Leak Reporting and Alert App,"** aims to streamline the reporting of water leaks in communities and municipalities by offering a robust mobile platform for both residents and municipal staff. The app’s primary goal is to reduce response time for water leak repairs, ensure better community engagement, and automate the leak detection and reporting process.

Type of System: Mobile-based application designed to be user-friendly and efficient for real-time water leak reporting.

User Platforms: The system will be compatible with both Android and iOS platforms, ensuring wide accessibility for residents and municipal staff.

Preferred Development Tools: React Native for front-end mobile application development, Node.js for back-end services, MongoDB as the database, and Visual Studio Code as the primary code editor.

**System Overview**

Hydro Check enables residents to report water leaks instantly, and municipalities can respond efficiently by managing reports through an organized backend interface. The system also facilitates the automation of the reporting process, eliminating manual methods that are often slow and inefficient.

The system’s development involves two primary components:

1. Front-End Development: Utilizes React Native to ensure a responsive and intuitive mobile application.

2. Back-End Development: Node.js powers the back-end functionalities, ensuring fast, reliable, and scalable processing for data storage, management, and real-time notifications.

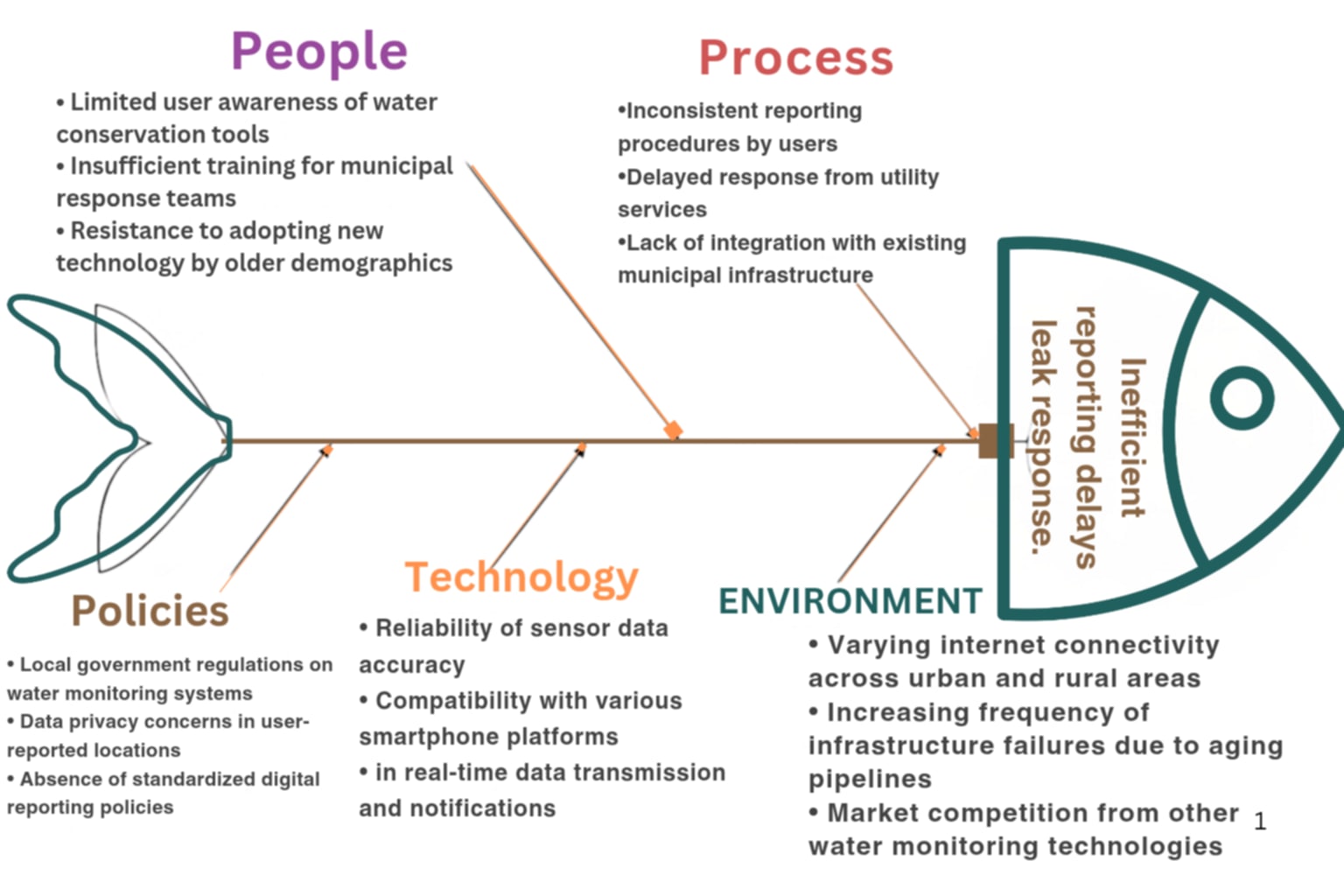
Through this design, the app aims to optimize water leak detection, response times, and transparency, which contributes to reduced water wastage and improved public services.

The presentation and discussion of the software project will utilize a range of diagrams and illustrations to effectively depict the system's operations and showcase its overall design.

**Fishbone Diagram.** The Fishbone Diagram, also known as the Ishikawa Diagram or Cause-and-Effect Diagram, helps in systematically identifying and categorizing the potential root causes of problems that may affect the functionality, usability, and adoption of the app. The diagram consists of a "head," representing the primary issue (in this case, the inefficiency of manual leak reporting), and "bones," branching off to identify contributing factors such as technological, environmental, and human factors. According to Duffy (2021), the diagram organizes contributing Elements into categories, allowing for thorough exploration and solution development. This approach proves effective across various sectors, including technology, manufacturing, and public service. Coccia (2020) emphasized the Fishbone Diagram's utility in visualizing the forces behind general-purpose technologies and innovations, promoting structured thinking and problem identification. Furthermore, Kasim et al. (2021) outlined the diagram’s standard procedural phases: preparation, drawing, identification, and production. This framework supports a clear and methodical exploration of a problem's possible origins, making it especially valuable in mobile application development contexts.

**Figure 1**

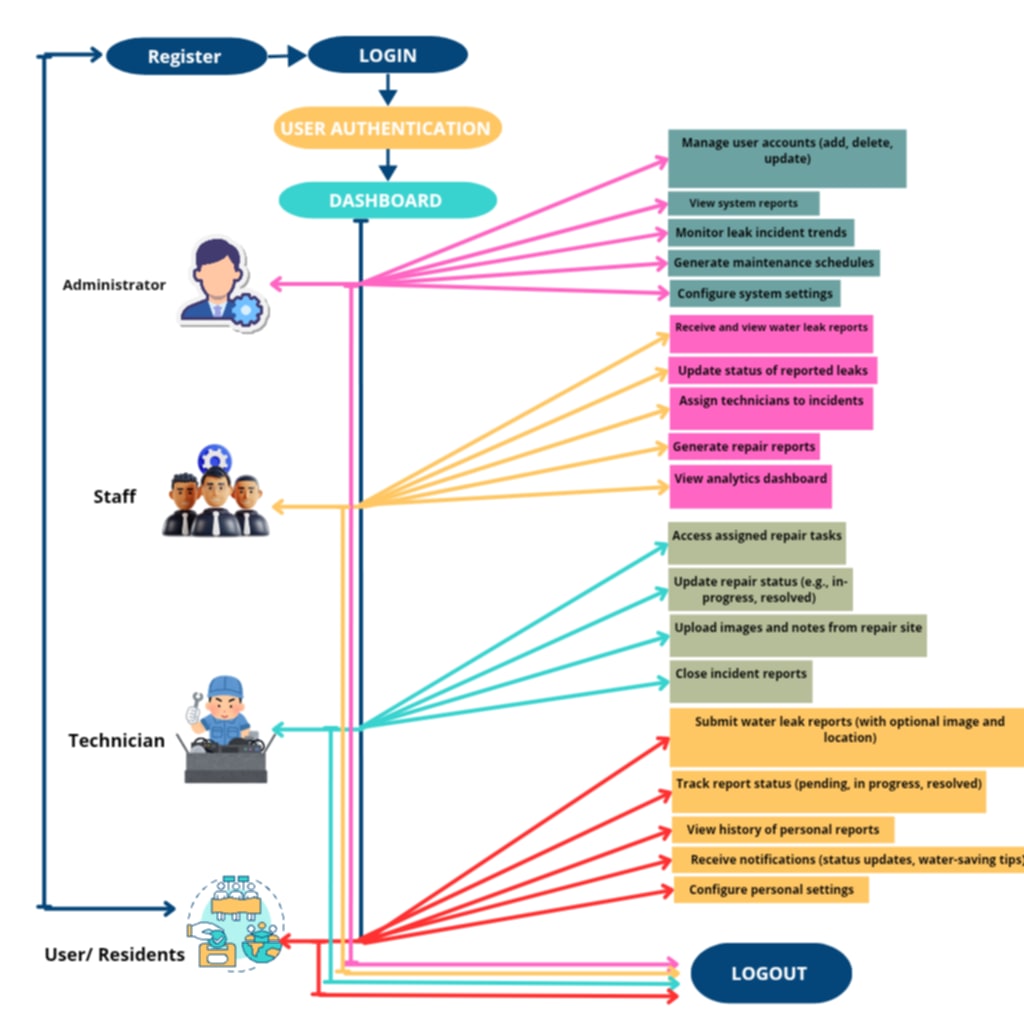
*Fishbone Diagram*

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This structured analysis assists in uncovering both internal and external issues that could affects this app’s functionality, usability, and adoption. By understanding these root causes, developers and stakeholders can devise practical strategies to address them and improve the overall effectiveness of the solution.

**Use Case Diagram.** The Use Case Diagram offers a visual representation of the interactions between users (residents, municipal staff, technicians, and administrators) and the system. It highlights the essential functions the system must perform and clarifies the roles of each user in the process. According to Mahardika, Merani, and Suseno (2024), use case diagrams are instrumental in identifying functional requirements, ensuring that both developers and stakeholders have a clear understanding of user interactions, while class diagrams help define involved entities and their attributes. The use case diagram not only supports efficient system planning but also serves as a communication bridge between developers and non-technical stakeholders. It guides development teams by clarifying user expectations, supporting the design of user-centric solutions that align with real-world needs.

**Figure 2**

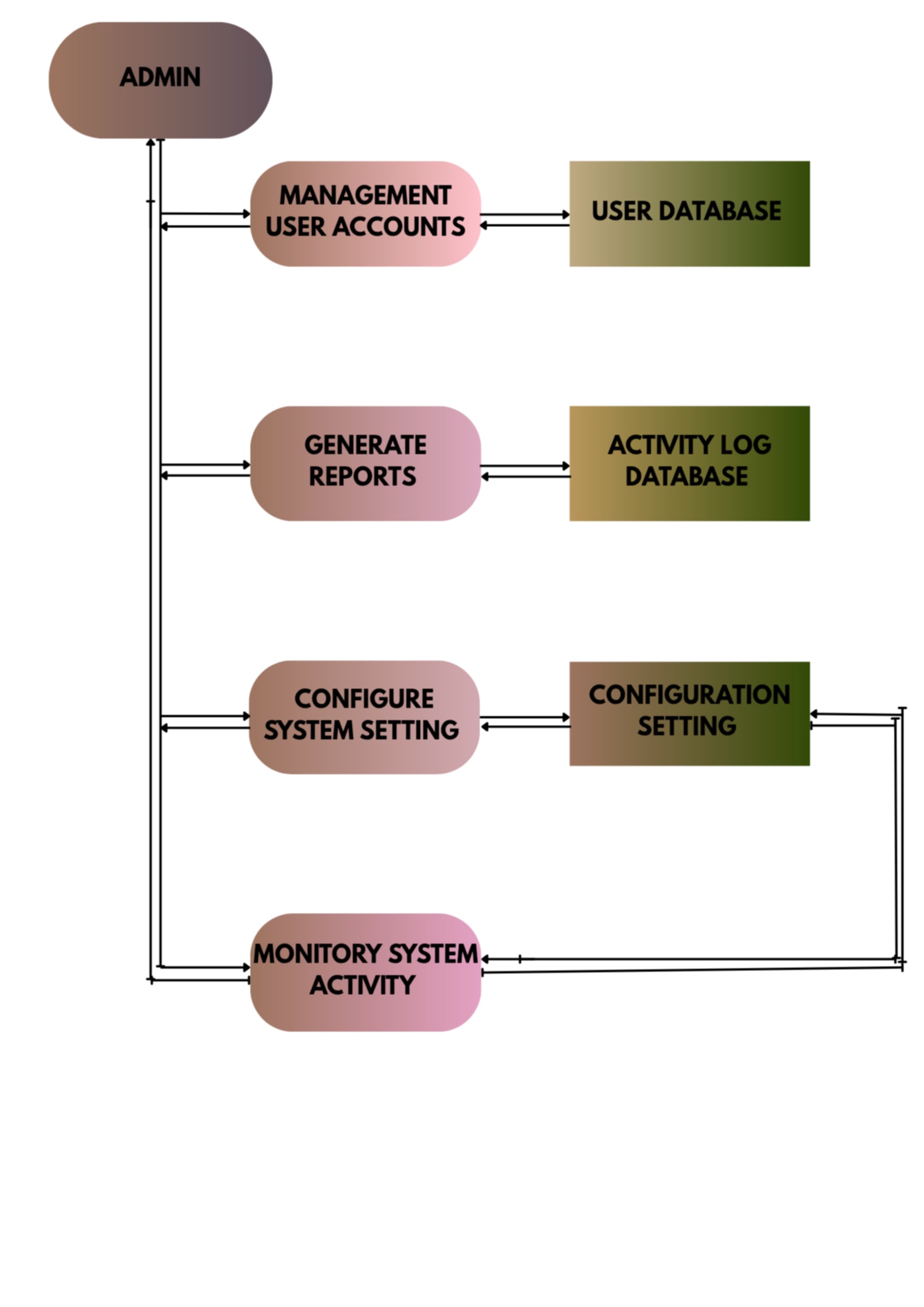
*Use Case Diagram*

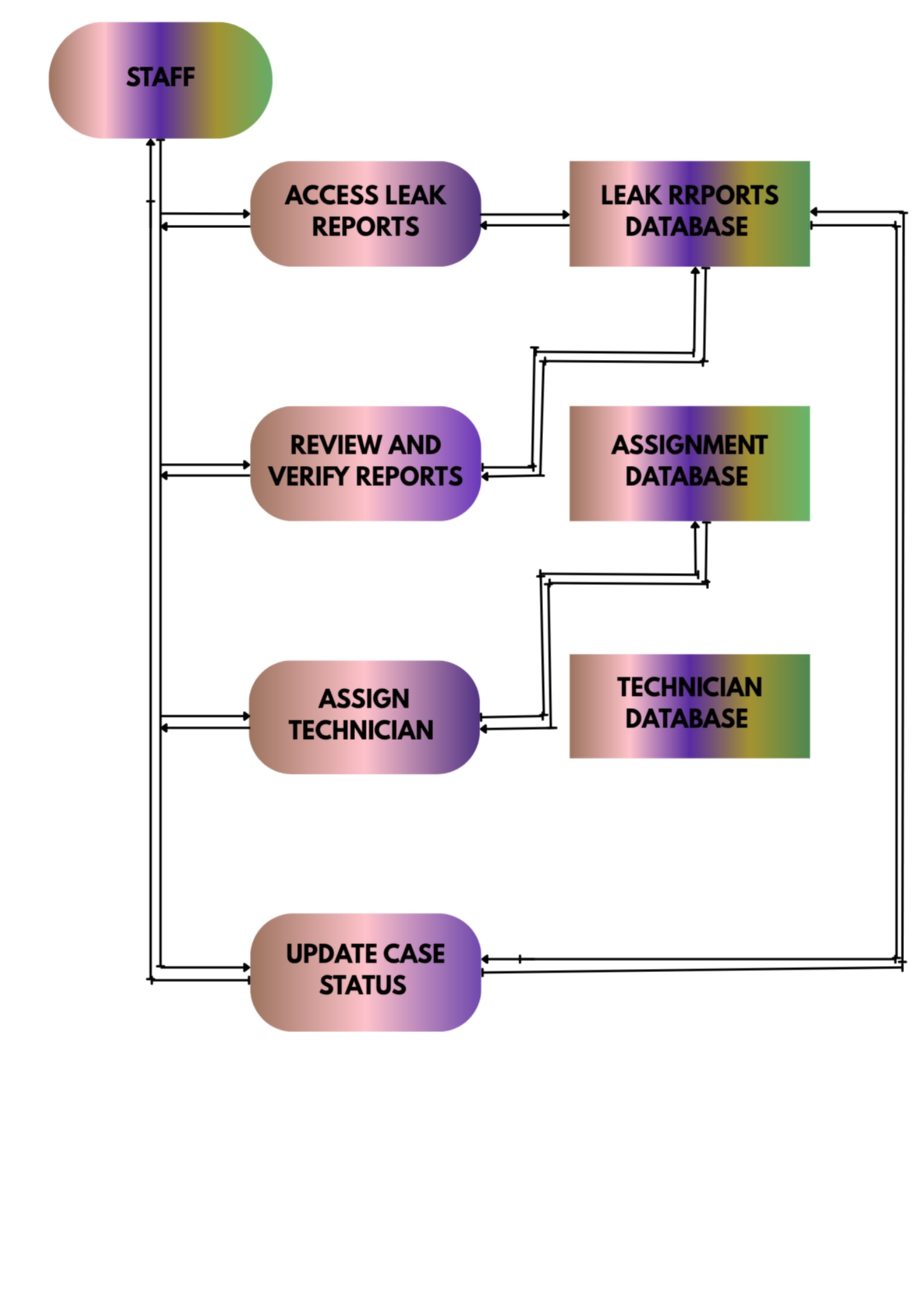
This structured interaction overview allows for a clear understanding of each role within the app ecosystem and the specific services each actor can perform. By identifying these interactions early in the development cycle, the project team can ensure a comprehensive user experience that promotes effective water leak reporting, faster response, and increased accountability.

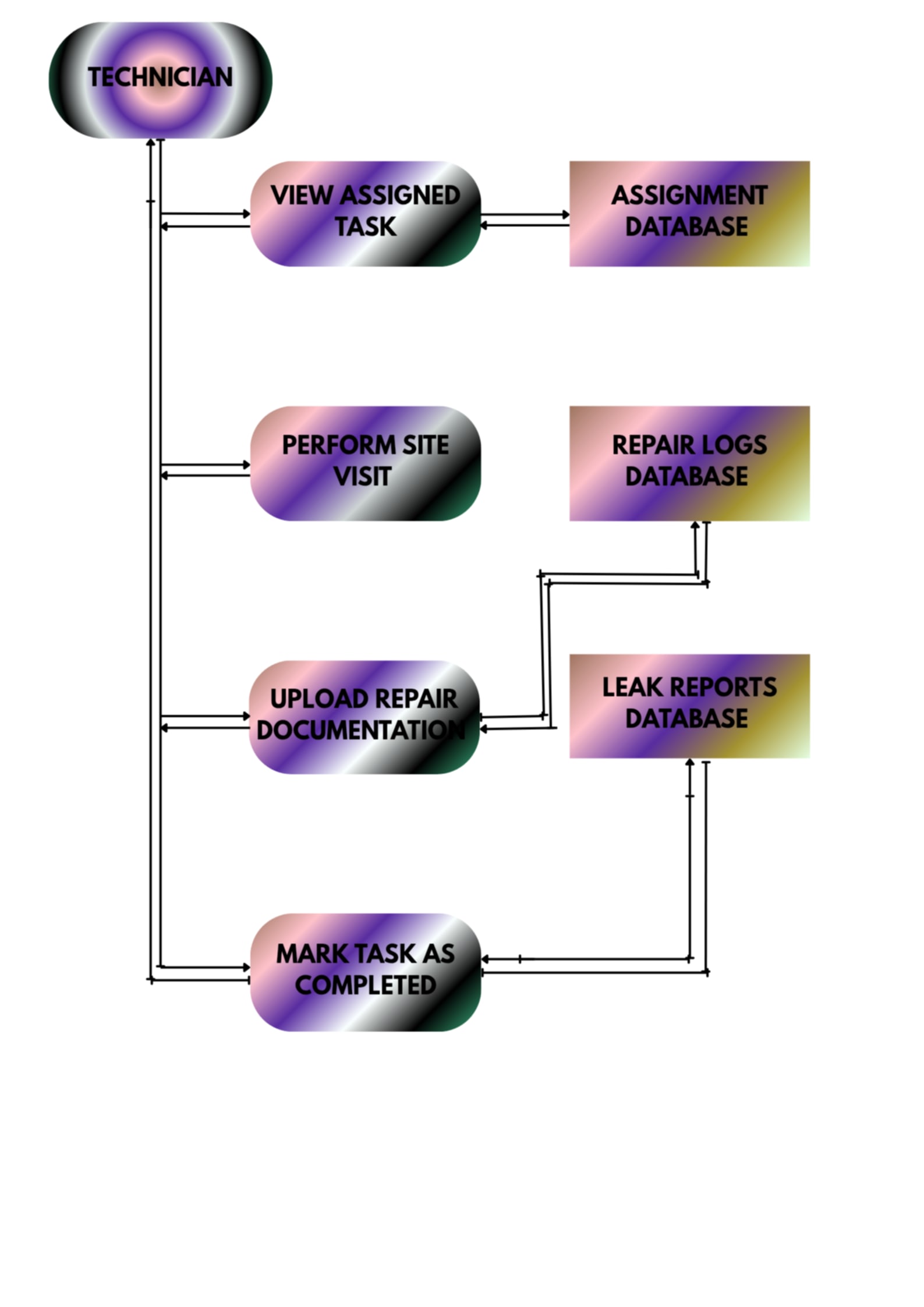
**Data Flow Diagram.** A Data Flow Diagram (DFD) visually represents the flow of data through the system, showing how different components (such as users, data stores, and processing units) interact. It emphasizes the movement of data from initial report submission by residents to its eventual resolution by technicians and administrators. Data Flow Diagrams (DFDs), plays an essential role in modern software development, aiding in the design, understanding, and communication of system structures and potential security and privacy threats. (Herwanto, 2024).

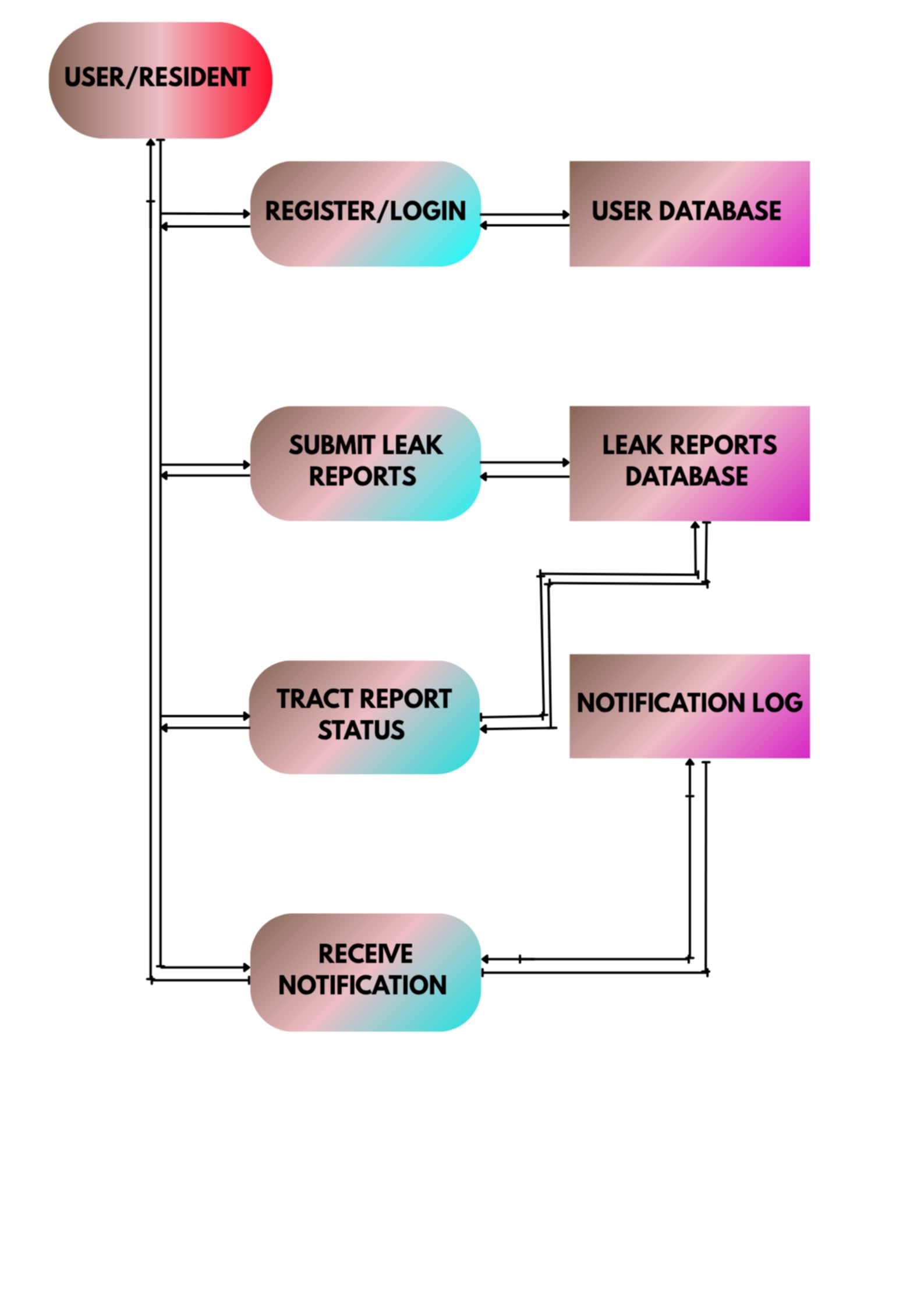
**Figure 3**

*Data Flow Diagram*

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This application is structured to manage and streamline the reporting and resolution of water leak issues within a community. It operates through four primary user roles Resident, Staff, Technician, and Administrator each with specific functions, responsibilities, and interactions within the system. The app is data-driven, ensuring organized operations from initial user registration to task completion and system monitoring. Residents access the app to register or log in, allowing them to report water leaks in their area. These reports are directly saved in the leak reports database. Once submitted, residents can track the progress of their reports through the app interface and receive updates via the built-in notification system. This ensures transparency and builds trust between the community and the municipal services. Staff members, usually employed by the local municipality, review the incoming reports from the database using the app’s backend interface. They verify the details and legitimacy of each report and then assign a technician to handle the issue. Assignments are logged in a dedicated database. Staff can also update the case status, ensuring that the report lifecycle from submission to resolution is clearly documented and accessible. Technicians, who receive assignments via the mobile app, view their list of tasks and conduct physical inspections or repairs at the reported locations. They use the app to upload repair documentation, including photos and notes, to the repair logs database. Once a repair is completed, they mark the task as complete, automatically updating the report status and informing both staff and the resident. The administrator oversees the entire system through an advanced module within the app or web dashboard. They manage user accounts, configure app settings, and monitor system-wide activity. The app supports generating reports and logs that help in auditing and performance evaluations. Data stores such as user databases, configuration settings, and activity logs enable the admin to ensure the app functions reliably and securely. This application, through its well-defined flow of data and responsibilities, enhances the efficiency of leak detection and resolution in local communities. It ensures clear communication between all involved roles, promotes accountability, and supports data-driven decision-making by automating and documenting each step of the process.

**Technical Requirements**

**Hardware.** Hardware refers to the physical components of a computer system, including both internal parts and external devices. The internal hardware is responsible for essential operations such as data storage, input processing, and output generation. On the other hand, external peripherals such as display screens, keyboards, printers, and other connected devices enable users to interact more effectively with the system, contributing to a more functional and user-friendly computing experience.

The hardware specification used in the development of the proposed system

is stated in detail:

**Laptop Model:** Acer Aspire AL14-31P

**Windows Version:** Windows 11 Home Single Language

**Processor:**  Intel(R) Core (TM) i3-N300 800 MHz

**Installed Memory (RAM):** 8.00 GB (7.73 GB usable)

**System Type:** 64-bit operating system, x64-based processor

**Software.** According to Britannica, software is a set of instructions that tells a computer what to do. It consists of computer programs, libraries, and related non-executable data that are necessary for running programs. Software can be classified into two broad categories: system software and application software. System software provides the basic functions necessary for the computer to operate, such as operating systems, device drivers, and utilities. Application software, on the other hand, is designed to perform specific tasks or functions, such as word processing, graphic design, or accounting. Software is typically created by software developers and can be distributed in a variety of ways, including as a digital download, on physical media such as a CD or DVD, or through cloud-based services.

Software development utilizes a structured and precise set of descriptions to delineate the software employed. These descriptions are as follows:

*Visual Studio Code.* Visual Studio Code, developed by Microsoft, stands out as a highly versatile and efficient source-code editor favored by a diverse community of developers worldwide. Offering a rich array of features, Visual Studio Code provides developers with a seamless coding experience across various programming domains, including web development, mobile app creation, and cloud computing. Its hallmark features, such as IntelliSense for intelligent code completion and syntax highlighting, significantly expedite the coding process while ensuring accuracy. Moreover, Visual Studio Code boasts robust debugging support, enabling developers to identify and rectify errors directly within the editor. Its extensibility is a key highlight, with a vast ecosystem of extensions available to tailor the editor's functionality to specific programming languages, frameworks, and workflows. Furthermore, Visual Studio Code integrates an integrated terminal, facilitating seamless execution of command-line tasks within the editor environment. With native integration with version control systems like Git and extensive customization options, Visual Studio Code empowers developers to craft their ideal coding environment tailored to their unique preferences and requirements. Overall, Visual Studio Code's widespread adoption and acclaim stem from its unmatched combination of performance, versatility, and extensive feature set, making it an indispensable tool in the modern software development landscape (Microsoft Corporation, 2021).

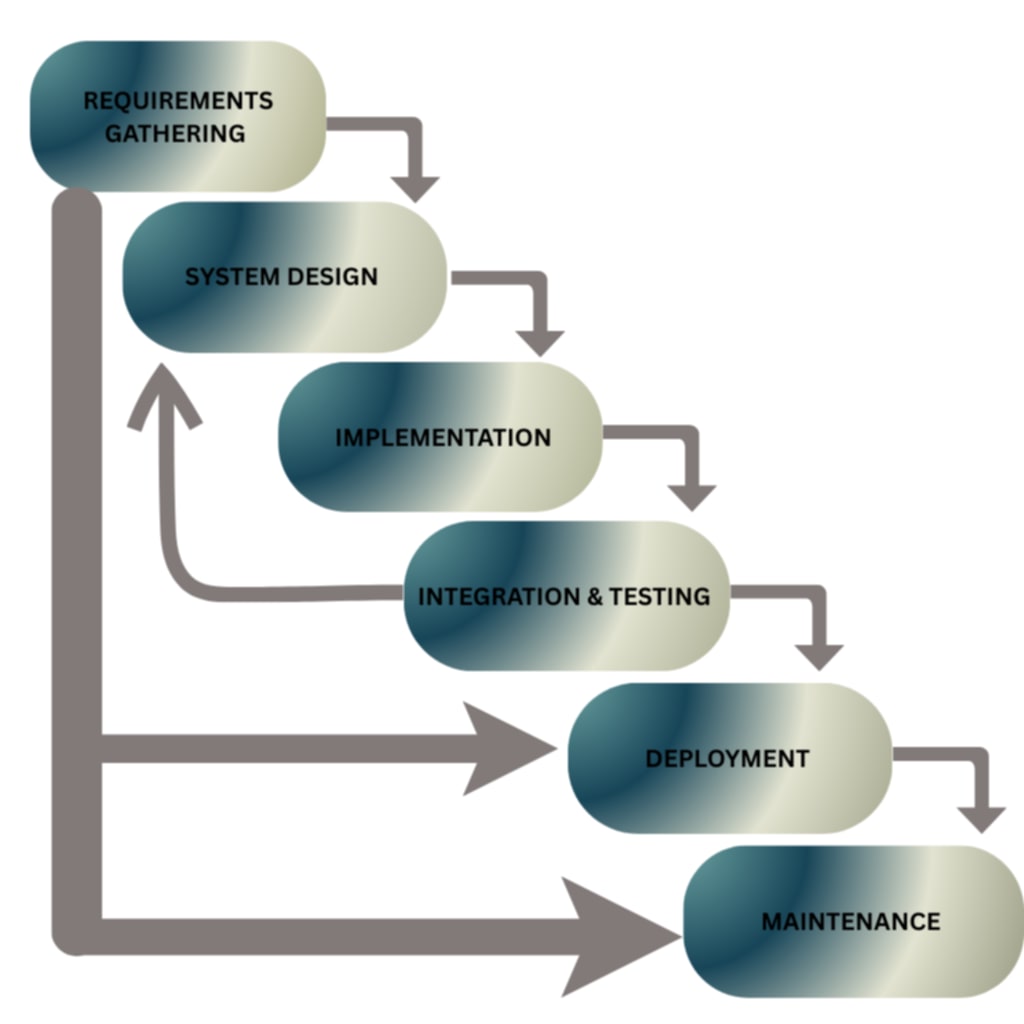
This software acts as the primary editor or Integrated Development Environment (IDE) where all editing and debugging tasks throughout the development process are performed. MongoDB Is a popular open-source, NoSQL database program that stores data in JSON-like documents with dynamic schemas, known as BSON (Binary JSON). It is designed for flexibility, scalability, and high performance, making it suitable for a wide range of applications, from small-scale projects to large-scale enterprise systems. MongoDB uses a distributed architecture, allowing for horizontal scalability by distributing data across multiple servers or clusters. It offers features such as ad hoc queries, indexing, replication, and sharding, making it a powerful and versatile database solution for modern applications (MongoDB, Inc., n.d.).

The proposed system will rely on this platform as its server, and all functionalities will be accessible only upon its launch.

**Software Development Models and Procedures**

The Modified Waterfall model allowed for a structured approach while incorporating flexibility and iterations. Initially, requirements were gathered, followed by design, implementation, testing, and deployment phases. However, there were feedback loops between phases, enabling adjustments based on stakeholder input. This iterative process ensured the final product met user needs effectively (Alsagaby & Alharbi, 2021). The developer utilized this software development model, which encompasses a series of processes and methods, to achieve the desired outcome of the proposed system. They applied this model while considering factors such as a thorough understanding of system requirements, time constraints, addressing skill gaps and training needs as a software developer, and suitability for web application development.

**Figure 4**

*Modified Waterfall Model* Here are the tasks that a developer should undertake during the development of a system or website:

**Requirements Analysis.** The phase marks the beginning of the development process and involves working closely with stakeholders to identify and understand what the system or website needs to accomplish. The goal is to clearly define its purpose, key functions, and limitations. During this stage, the developer collects user input, outlines the necessary features, and sets specific goals to ensure the project meets the client’s expectations. After the pre-oral defense, panelists often suggest improvements, which may lead the developer to revisit this phase. Revisiting the analysis helps adjust and improve the original plan based on the feedback received, leading to a better and more suitable final product.

**System Design.** Once the requirements have been clearly defined, the developer proceeds to the design stage, where the focus shifts to outlining how the system or website will function and appear. This stage involves planning the system’s layout, structure, and interface, turning the gathered requirements into concrete design elements. The developer pays close attention to aspects such as user-friendliness, future scalability, and ease of maintenance to ensure the system works smoothly and can be improved over time. Feedback from the pre-oral defense often plays a role here, as suggestions from the panel may require the developer to revisit earlier decisions. This back-and-forth process helps improve the overall design and ensures the final output is more aligned with the users' needs and expectations.

**Implementation**. The implementation phase marks a crucial transition from design to development, where the developer begins the process of transforming finalized design specifications into actual code. During this phase, the developer engages in writing, coding, and integrating the various components of the system or website, ensuring that each element aligns with the established design framework. Adherence to coding standards, best practices, and version control techniques is paramount to maintain code quality and facilitate effective collaboration among team members. Moreover, feedback and recommendations from the pre-oral defense may necessitate revisiting both the requirements analysis and design phases. This iterative process allows the development team to refine and adjust the implementation approach, ensuring that the final product meets stakeholder expectations and delivers a robust solution.

**Testing.** This stage represents the shift from planning to actual development, where the developer starts building the system or website based on the approved design. It involves writing and assembling the code needed to bring each planned feature to life, making sure every component functions as intended within the system structure. Throughout this process, the developer follows standard coding guidelines, uses version control tools, and applies best practices to ensure the code is clean, reliable, and easy to manage. If suggestions were raised during the pre-oral defense, the developer might need to go back and revise earlier phases like requirements or design. These revisions help fine-tune the system during development and lead to a final product that better fits the project goals and user expectations.

**Deployment**: After thorough testing and confirmation that the system functions as expected, the developer moves on to the deployment phase. This involves preparing the system or website for live use, which includes setting up configurations, packaging the application properly, and transferring it to the chosen hosting platform or server. During this stage, the developer works closely with system administrators and other involved parties to ensure a smooth rollout, aiming to avoid interruptions or technical issues during the launch. The success of this phase is reflected in the system’s evaluation, which achieved a commendable overall grand mean of 4.72 based on ISO 25010 quality attributes such as functionality, usability, security, and maintainability. This score highlights the system’s reliability and effectiveness in delivering a quality user experience in a real-world environment.

**Maintenance**. Finally, once the application is deployed, the developer transitions into the maintenance phase, which focuses on ensuring the system continues to function effectively in a live environment. This includes regularly monitoring its performance, responding to user feedback, and resolving any technical problems or bugs that surface after deployment. In addition to troubleshooting, the developer also looks for ways to enhance the system by introducing updates, performance improvements, or new features, with the goal of maintaining a high level of reliability and providing a better user experience over time.

**Software Cost Estimation**

Cost estimation is a critical aspect of software development. For this project, the COCOMO (Constructive Cost Model) is used to estimate the software development cost, effort, and timeline. COCOMO provides estimates at three levels: Basic, Intermediate, and Detailed. These estimates help guide the planning, resource allocation, and scheduling of the project. Accurate cost estimation plays a key role in avoiding project delays and ensuring the timely delivery of the app. Estimating the cost of software projects is a significant and ongoing challenge in software engineering. Inaccurate estimates can lead to serious setbacks for software companies, making cost estimation a crucial aspect of project planning. To address this, researchers have continuously improved various SCE models over the years. One of the most recognized models is the **Constructive Cost Model (COCOMO)** (Gandomani, Dashti & Nafchi, 2022).

COCOMO offers a systematic method for predicting the cost, effort, and timeline required to complete a software project. It is divided into three main levels: **Basic**, **Intermediate**, and **Detailed**. The **Basic COCOMO** model gives a rough estimate of the effort based on the size of the project, usually measured by metrics such as lines of code or function points. This level is useful for providing an early overview of the project's scope. The **Intermediate COCOMO** model builds upon this by including additional considerations like the complexity of the project, the working environment, and the experience level of the development team. These elements help refine the estimation and guide better planning. The **Detailed COCOMO** model provides the most comprehensive view, factoring in elements such as staff capability, project management practices, and organizational structures. Although it requires more in-depth information, it produces more accurate and reliable forecasts (Gandomani, Dashti & Nafchi, 2022).

In a broader sense, accurate cost estimation plays a vital role in software engineering by aiding in realistic scheduling, resource distribution, and risk management (Zhang et al., 2023). It supports better decision-making, helps prevent project overruns, and increases the chances of successful delivery. This is particularly important in mobile app development, where fast-paced innovation and tight deadlines are common (Murad, Abdullah & Rosli, 2021).

In conclusion, models like COCOMO are essential tools in project management, helping developers and managers plan effectively, reduce uncertainties, and improve overall project outcomes. Accurate cost estimation is not just a budgeting exercise it’s a foundational element for sustainable and successful software development.