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Design and Technical Evaluation of LISA (Local Irrigation System Assessment): A Mobile and Web-Based Platform for Farm Water Availability Monitoring

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Abstract*: This study presents the development and evaluation of the Local Irrigation System Assessment (LISA), a web-based platform designed to monitor farm water availability and support informed irrigation management. The core objective of the research is to address the lack of accessible, real-time irrigation monitoring tools for rural farming communities, particularly in low-bandwidth environments. LISA was developed using open-source web technologies, with a focus on usability, responsiveness, and accessibility. The system features a dashboard for monitoring water availability, user-specific data visualization, and notification alerts to assist farmers and agricultural stakeholders make timely irrigation decisions. The development process followed a user-centred and iterative design approach to ensure simplicity for users with varying levels of digital literacy. To evaluate the platform's technical quality, the study employed Google Lighthouse, an automated auditing tool for web performance. The website was assessed across four key metrics: Performance, Accessibility, Best Practices, and SEO (Search Engine Optimization). Evaluation results demonstrated high scores in Accessibility and SEO, indicating strong compliance with global web standards and discoverability. Best Practices scores confirmed adherence to modern development protocols, while Performance scores identified optimization opportunities, particularly in image compression and script loading. This research contributes a practical framework for building web platforms that meet critical technical standards in rural and agricultural contexts. The study highlights how digital platforms can be optimized for broader adoption and greater impact by integrating usability with performance evaluation tools. The LISA platform exemplifies how data-driven tools can be leveraged to empower local farmers and improve the effectiveness of irrigation systems through timely, accessible, and actionable insights.

***Keywords*: LISA (Local Irrigation System Assessment), Irrigation Management, Water Resource Optimization, Mobile and Web-Based Platform, Real-Time Data Collection, Sustainable Agriculture.**

Abbreviations:
NIA: National Irrigation Administration
WSNs: Wireless Sensor Networks
LISA: Local Irrigation System Assessment
UCD: User-Centred Design
CLS: Cumulative Layout Shift

I. INTRODUCTION

Efficient water management is essential for sustainable agriculture, particularly in regions where water scarcity significantly impacts crop productivity [1]. Traditional irrigation methods often result in inefficient water distribution, leading to the overuse or underutilization of water resources, which reduces crop yields and contributes to soil degradation and environmental challenges [2]. As agriculture faces mounting climate change and population growth pressures, the demand for innovative irrigation solutions has become increasingly critical [3].

Mobile and web-based technologies have emerged to address these challenges by optimizing irrigation management. For instance, agro-hydrological software solutions provide farm-scale water use indicators, enabling farmers to make informed decisions about irrigation strategies [3]. Similarly, global platforms like the Cool Farm Tool Water assess water consumption in crop production, promoting sustainable water use among farmers [4]. Mobile applications have also been introduced to manage automated irrigation systems, enhancing the efficiency of water distribution on farms [5].

Beyond automation, innovative irrigation systems leveraging wireless sensor networks (WSNs) have been proposed to improve water conservation efforts [6]. Research has shown that smartphone applications offering real-time irrigation scheduling in Mediterranean environments can significantly enhance water use efficiency [7]. Furthermore, mobile applications based on intelligent sensor cloud approaches have been developed to support sustainable irrigation water usage by providing decision support systems for farmers [8].

Assessment platforms focusing on water and energy efficiency have also been created to evaluate and improve the performance of collective irrigation systems [9]. At the same time, mobile IT applications offer practical solutions for farmers to monitor and manage on-farm water resources [10].

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Despite these technological advancements, many existing irrigation management tools are designed for broad regional or global applications and often lack localised data that addresses the specific challenges of smallholder farmers. The reliance on generalized models limits the effectiveness of these tools in diverse agricultural settings, where variations in climate, soil conditions, and farming practices are significant. Moreover, a gap remains in integrating real-time, farmer-generated data with government agencies, which limits accurate irrigation decision-making at the local level.

To bridge this gap, this study presents the design and technical evaluation of the Local Irrigation System Assessment (LISA) platform, a mobile and web-based tool for monitoring farm water availability. The LISA platform comprises a mobile application developed using React Native, which enables farmers and enumerators to capture images and conduct soil moisture surveys. Additionally, it features a web application built with React.js that processes and displays the collected data through an interactive map interface. By integrating real-time, geotagged field data into a centralized system, LISA is a decision-support tool for government agencies like the National Irrigation Administration (NIA), facilitating more effective and data-driven water resource management.

The primary objective of this study is to develop an accessible and user-centred digital platform that simplifies real-time data collection and visualisation for farm water availability monitoring. In addition to system design, this study also evaluates the technical performance of the web-based platform using Google Lighthouse, assessing factors such as performance, accessibility, best practices, and SEO compliance.

By focusing on localized, real-time data collection and emphasizing user accessibility, the LISA platform aims to empower smallholder farmers and policymakers with technology-driven insights to enhance irrigation practices, promote sustainable water use, and improve overall water resource management in agriculture.

II. METHODOLOGY

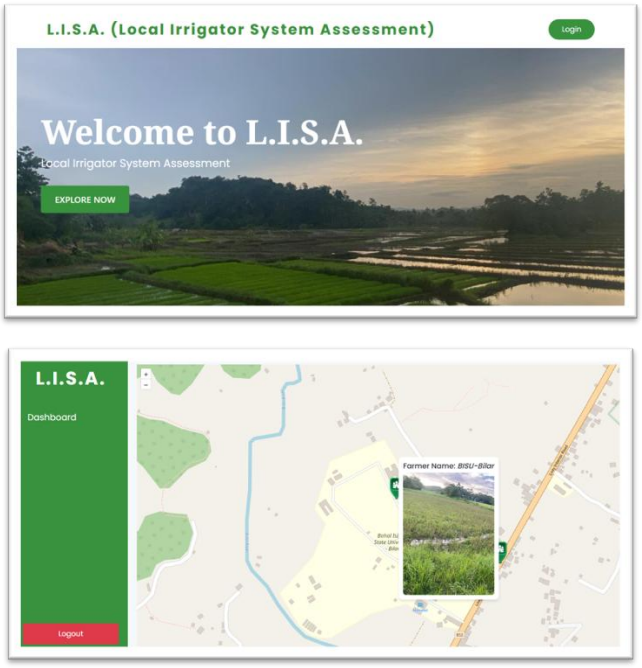
This study adopts a design and development research methodology to create the Local Irrigation System Assessment (LISA) platform, a mobile and web-based tool designed to enhance farm water management. The research focuses on developing a comprehensive system that integrates real-time data collection, visualization, and mapping features, offering a practical solution for farmers and government agencies involved in irrigation planning and water distribution. The development process follows an iterative design approach, guided by user-centred design (UCD) principles, ensuring the platform aligns with the specific needs of smallholder farmers and policymakers. This iterative process emphasizes continuous refinement through stakeholder feedback, usability testing, and incremental improvements to optimize the platform's functionality and accessibility.

The design phase of the LISA platform began with an extensive review of existing irrigation management tools, identifying critical gaps in real-time data integration, user-friendly interfaces, and localized applications. Many existing systems rely on static, pre-recorded data, limiting their accuracy in dynamic agricultural settings. Furthermore, existing tools often cater to technically skilled users, creating barriers for smallholder farmers with limited technological experience. Additionally, many systems address broad regional scales, making it difficult to adapt to specific agricultural environments with unique climate and soil conditions. In response to these limitations, LISA was conceptualized as a mobile and web-based solution that enables real-time assessment of farm water availability using geotagged data collected directly from farmers.

The mobile application was developed using React Native, a cross-platform framework that ensures compatibility with both Android and iOS devices. The app enables farmers and enumerators to conduct surveys by recording water availability and soil moisture conditions using a digital survey form and image capture feature. Image-based validation enhances the accuracy of farm condition assessments. Additionally, the app features offline functionality, allowing data storage when an internet connection is unavailable and automatic upload once the connection is restored. This ensures continuous data collection even in remote areas with limited network coverage.

To complement the mobile application, a web-based platform was developed using React.js, providing an intuitive interface for policymakers and government agencies to visualise farm water availability. The web application features an interactive map that dynamically displays survey data, allowing agencies such as the National Irrigation Administration (NIA) to monitor and assess irrigation needs across various locations. It also serves as a data validation tool, allowing authorities to cross-check farmer-generated data against existing irrigation datasets. The platform features an administrative panel that enables policymakers to analyse trends and generate reports to support data-driven decision-making.

The development process was iterative, with continuous collaboration among key stakeholders, including farmers and government representatives. Farmers provided feedback on the usability of the mobile survey form and image-capturing features, ensuring the system remained accessible to users with varying levels of technological expertise. Government agencies evaluated the utility of the web-based dashboard in irrigation planning and resource allocation. The researcher conducted Initial testing to assess the platform's usability, data processing efficiency, and overall performance. This phase identified areas for improvement, such as optimization of data processing speed, scalability, and mobile interface enhancements for better accessibility. These insights were incorporated into successive development cycles to refine. The platform.



[Fig.1: L.I.S.A. Mobile Survey Form]

To ensure the platform meets high standards for performance and accessibility, the web-based platform underwent a technical evaluation using Google Lighthouse. The review assessed key performance indicators, including performance, accessibility, best practices, and SEO compliance. This evaluation provided critical insights into the technical aspects of the web application, ensuring that it meets industry standards for speed, responsiveness, and user-friendliness.

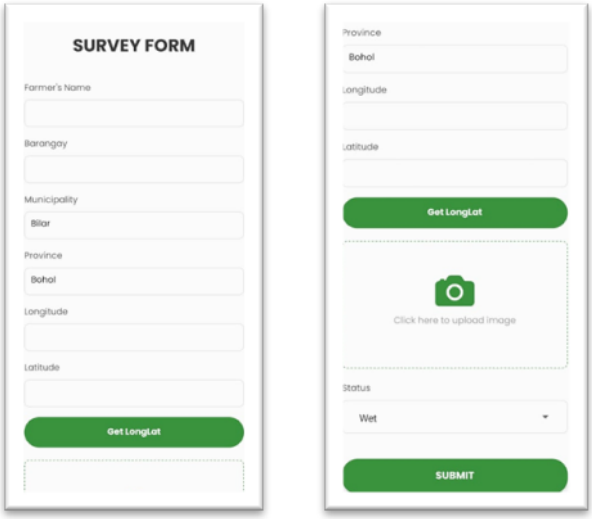
The methodology focuses on designing and developing a practical tool to address the need for real-time, user-friendly irrigation management solutions. By integrating mobile and web-based technologies, the LISA platform offers a valuable resource for smallholder farmers and policymakers, enabling them to make informed decisions about water resource management. Its emphasis on real-time data collection, visualization, and accessibility ensures that localized agricultural needs are met, promoting sustainable irrigation practices.

III. RESULTS AND DISCUSSION

The Local Irrigation System Assessment (LISA) platform, comprising a mobile and web-based application, was evaluated for its functionality and performance during development. The mobile application, created using React Native, enables farmers and enumerators to collect structured data, including images of farm fields and soil moisture readings, which is crucial for monitoring farm water availability. The web-based platform, developed using React.js, features a dynamic mapping tool that visualises collected data on an interactive map, providing valuable insights to government agencies such as the National Irrigation Administration (NIA). Both applications were tested for usability, and initial evaluations revealed that the system was easy to use and efficient for real-time data collection and visualization, confirming that the platform met its primary objectives.

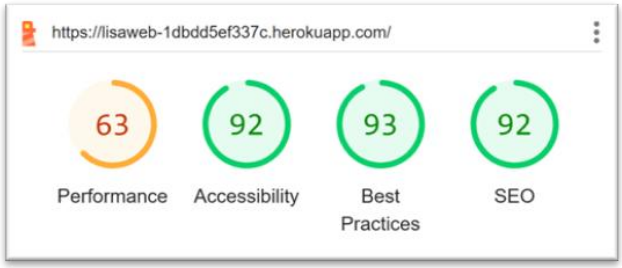
However, the evaluations also identified areas for improvement. The system's data processing speed and scalability require further optimisation, particularly as survey data volumes increase. Future development will improve these aspects to ensure the platform can handle large datasets and render maps more efficiently. Despite these limitations, the LISA platform successfully integrates mobile-based data collection with web-based visualization, offering a practical solution for improving water management in agriculture.

Figure 1 shows the homepage and dashboard of the LISA web application, which displays a dynamic map of farm water availability. The web-based platform's mapping feature allows government agencies to monitor water distribution across agricultural regions. The clear and organized visualization of survey data supports decision-making by showcasing trends and potential gaps in the current water management practices. This visualization aids in better resource allocation and planning for sustainable irrigation management.



[Fig.2: L.I.S.A. Mobile Survey Form]

Figure 2 presents the survey form of the LISA mobile application, demonstrating the simple yet effective layout for capturing farm water availability data. The design of the survey form is intuitive and user-friendly, allowing even farmers with minimal technical experience to record farm conditions easily. This aligns with the study's goal of developing a structured, real-time data collection system to improve water resource management in agriculture.



[Fig.3: Google Lighthouse Result]

Figure 3 presents the results of The Google Lighthouse assessment for the LISA web application shows the platform's performance across several key metrics. The overall performance score is 63, with the following

individual scores: Performance (22), Speed Index (9.3 seconds), and Cumulative Layout Shift (CLS) of 0.106, indicating some issues with layout stability. The platform's accessibility score is 92, which is relatively high but still leaves room for improvement, particularly in areas such as ARIA usage and contrast ratio adjustments for enhanced legibility. The Best Practices score of 93 highlights good adherence to development guidelines, but also points out issues with browser errors and the absence of source maps for large first-party JavaScript files. Lastly, the SEO score of 92 is strong, although the robots.txt file issue was flagged, which may affect how search engines index the platform.

The Lighthouse results indicate that while the LISA platform performs well in some areas, there are still significant opportunities for optimization, particularly in performance and accessibility. The mobile and web applications should be refined further to enhance loading speeds, stability, and accessibility for a broader range of users, especially those relying on assistive technologies. Addressing these issues will be a priority in future development phases to ensure the platform meets the needs of all users and remains an effective tool for sustainable water resource management in agriculture.

IV. CONCLUSION AND RECOMMENDATIONS

The development of the Local Irrigation System Assessment (LISA) platform has successfully introduced a mobile and web-based solution designed to improve farm water management. By integrating real-time data collection, visualization, and mapping capabilities, the platform empowers farmers to assess soil moisture conditions. It provides government agencies with valuable decision-support tools for irrigation planning and management. The mobile application, developed using React Native, allows farmers to conduct image-based surveys, while the web application, built with React.js, dynamically visualizes water availability across agricultural areas. Initial testing confirmed that LISA is user-friendly, practical, and effective in streamlining data collection and visualization processes. However, further optimization is required to enhance data processing speed, scalability, and the overall user experience. Additionally, while this study focused on the design and development phases, comprehensive user testing involving farmers and policymakers is necessary to assess the platform's real-world applicability.

Future research should prioritise several key areas to enhance the LISA platform's effectiveness and adoption. Comprehensive user testing will provide valuable insights into the platform's usability, accessibility, and adoption among farmers and government agencies. Feedback gathered during this phase will be critical for refining the system's functionality and interface. Additionally, enhancing the platform's data processing capabilities and scalability is crucial to accommodate larger datasets and increased user activity, while ensuring seamless synchronisation between mobile and web applications.

Integrating Internet of Things (IoT)-based sensors for real-time monitoring of soil moisture and water levels could be explored to enhance data accuracy and enrich the platform's capabilities. This would combine manual surveys with automated environmental readings, providing more precise data for irrigation decisions. Expanding stakeholder engagement is critical, particularly through collaboration with local irrigation agencies, policymakers, and farmer cooperatives. This will help promote broader implementation and ensure ease of adoption, especially for smallholder farmers. Furthermore, the development of predictive analytics for irrigation planning, coupled with AI-driven insights to optimize irrigation schedules, will improve the decision-support features of the platform.

By addressing these recommendations, the LISA platform can evolve into a more scalable, data-driven, and farmer-centric solution, ultimately contributing to sustainable irrigation management and improving water resource efficiency in agriculture.

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DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
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AUTHOR'S PROFILE

Max Angelo D. Perin is a faculty member of the College of Technology at Bohol Island State University – Bilar Campus, Philippines. He holds a Master of Science in Computer Science from Cebu Institute of Technology–University, where his research focused on machine learning applications for indigenous script recognition. His notable graduate work includes the development of "EskayApp," an OCR transliteration and e-learning application for the Eskaya script, utilising k-nearest neighbours (k-NN) and image processing techniques. His research interests span computing, software engineering, machine learning, cultural informatics, and innovative agriculture technologies. Mr. Perin has contributed to multiple research projects integrating technology with artistic and practical applications throughout his academic career. Some of his notable projects include "eBaybayMo," a mobile application for transliterating Baybayin characters; "StenogrApp," which recognizes Gregg Shorthand strokes using Android-based machine learning; and "LetsuApp," an IoT monitoring platform for hydroponic lettuce farming. His studies have been presented in international conferences and published in indexed journals, emphasizing his commitment to technological innovation and sustainable development. In addition to research, Mr. Perin actively engages in academic mentorship and has participated in institutional research collaborations, particularly in areas where information technology intersects with local community development. His ongoing research focuses on innovative irrigation systems under the Project MAKASA initiative and cultural preservation technologies. He continues to advocate for the responsible use of artificial intelligence and digital solutions to address local and global challenges. Mr. Perin is a lifelong learner who aspires to contribute meaningfully to intelligent systems and information management, with a strong emphasis on inclusivity and accessibility.

Dr. Larmie S. Feliscuzo is a distinguished academic and administrator at the Cebu Institute of Technology – University (CIT-U) in Cebu City, Philippines. Serving as the Director of the Management Information Systems (MIS) Office and Head of the Center for E-Learning and Technology Education, she has been instrumental in steering CIT-U's digital transformation and artificial intelligence (AI) initiatives. Dr. Feliscuzo's academic journey is marked by a strong foundation in information technology, culminating in a Ph.D. Her research interests encompass artificial intelligence, natural language processing, human-computer interaction, data analytics, and e-learning. She has contributed to over 50 publications, reflecting her commitment to advancing knowledge in these domains. Among her notable works is the "Fish Species Detection Application (FiSDA)" in Leyte Gulf, which utilises convolutional neural networks for marine biodiversity assessment. She has also explored innovative city assessments in developing economies and developed models for medicinal plant classification using transfer learning techniques. Dr. Feliscuzo's dedication to continuous learning is evident through her completion of several executive education programs from the Wharton School, including "Artificial Intelligence for Business," "Digital Leadership," and "Managing in the Global Digital Economy." Her leadership at CIT-U extends beyond administrative roles; she actively mentors students and faculty, fostering a culture of innovation and excellence. Dr. Feliscuzo's contributions have significantly impacted the integration of technology in education and research, positioning CIT-U at the forefront of digital advancements in the region.

Dr. Chris Jordan G. Aliac is a seasoned academic and technology innovator currently serving as a Full Professor at the College of Computer Studies, Cebu Institute of Technology – University (CIT-U), Philippines. He earned his Ph.D. in Information Technology from CIT-U in March 2015, specialising in vision systems, artificial neural networks, robotics, and the Internet of Things (IoT). With over two decades of academic experience, Dr. Aliac has held various leadership roles, including Research Coordinator (2006–2018) and Manager of the CIT-U MakerSpace (2018–present). He also serves as an IT Security Consultant at CIT-U, contributing to the institution's digital transformation initiatives. Dr. Aliac's extensive research portfolio comprises over 30 publications in the fields of artificial intelligence, machine learning, computer vision, and Internet of Things (IoT) applications. Notable works include the "IoT Hydroponics Management System," "Jackfruit Fruit Damage Classification using Convolutional Neural Network," and "Medicinal Plant Classification using Convolutional Neural Network and Transfer Learning." His research often focuses on practical applications that address local challenges, such as agricultural productivity and environmental conservation. Beyond academia, Dr. Aliac has engaged in consultancy roles, including serving as a Project Consultant for TASEKO Systems Inc. and as the owner of Sentinel Home Automations. His contributions to research and innovation have been recognised with several awards, including Best Paper awards at national conferences and commendations from the Department of Science and Technology (DOST). Dr. Aliac's commitment to integrating technology with community development inspires students and professionals, fostering a culture of innovation and practical problem-solving.

Dr. Nelia Q. Catayas is an accomplished academic and researcher at Bohol Island State University (BISU) – Bilar Campus, Philippines. She holds a Doctor of Philosophy degree and specialises in Technology Management, with a strong focus on food science innovation, hospitality management, and sustainable local industry development. Dr. Catayas has made notable contributions to food product innovation, including the invention of shrimp-flavoured rice chips, which was officially filed with the Intellectual Property Office of the Philippines (IPOPhil) under application number 1/2020/050559. Her research interests encompass the development of value-added agricultural products, with a focus on utilising indigenous resources to enhance food security and promote local entrepreneurship. Throughout her career, Dr. Catayas has Been actively involved in academic research collaborations to improve agricultural practices, food processing methods, and rural development initiatives. She has participated in various conferences and institutional research programs that support sustainable economic growth through technological innovations in the food and hospitality sectors. Aside from research, Dr. Catayas is passionate about mentoring students and fostering innovation within the academic community. Her dedication to promoting applied research and community extension initiatives has significantly contributed to BISU's mission of advancing local industry through education and technology.