Develop A Referral System For Hospital

Thakshi Rajapaksha
Department of Computer Engineering
Faculty of Engineering
University of Sri Jayewardenepura
Nugegoda, Sri Lanka
en97627@foe.sjp.ac.lk

***Abstract*—This project focuses on developing a web-based referral system for hospital laboratories, addressing the inefficiencies and potential inaccuracies of traditional paper-based methods still prevalent in many government hospitals. The primary goal is to create a digital platform that streamlines the exchange of physician-prescribed test requests and subsequent results between physicians and laboratories, thereby enhancing the accuracy and efficiency of diagnostic services. The system aims to maintain a comprehensive record of patient information, including medical history and test results, ensuring seamless communication and coordination throughout the diagnostic process. The developed system will be user-friendly, catering to the needs of administrators, laboratory technicians, and physicians. It seeks to replicate the functionality of referral slips in a digital format, facilitating the transfer of samples to the appropriate laboratory and the delivery of test results to the relevant specializing physician. By implementing this system, the project aims to address the challenges associated with time wastage and the lack of consideration for a patient's collective medical history in traditional methods. Furthermore, this project was developed for run in local network. From this study, the technologies used in the optimizing the referral system implementation methodology, results, and further enhancements will be discussed.**

***Index Terms*—Referral Management, Local Network, Data Security, Hospital Laboratory, Web Application**

I. Introduction

There is a growing dependence on digital solutions in the healthcare industry. More than ever, healthcare organizations want to leverage technological solutions to improve operational effectiveness, patient care, and communication between medical professionals. One of the most significant processes in healthcare delivery is the referral system. Referral systems transfer patient information (including tests ordered by the physician or laboratory test results) among physicians, labs, and other healthcare institutions. Referral systems have traditionally been a paper-based system in healthcare organizations, particularly among government hospitals. However, as with any paper-based system, these are often inefficient, and lead to treatment inaccuracies, delays in patient care and follow-up, and missed opportunities for care - all due to ineffective data management and limited real-time communication.

The research work develops a web-based referral system that meets the needs of local network-operated hospital laboratories. The modern system works to digitize referrals by providing a smooth system to transfer physician-ordered test requests together with lab outcomes across medical facilities to improve provider-laboratory teamwork. The system addresses data accessibility problems along with coordination challenges to boost diagnosis precision and test processing speeds, as well as patient outcomes, by using a secure platform. The significance of this work lies in its potential to transform hospital workflows in settings where digital referral systems are underdeveloped.

The current study investigates e-referral system scarcity in resource-limited government hospitals because most healthcare facilities have adopted electronic patient information systems [1]. Insufficient systems integration leads hospitals to use resources sub-optimally as well as deliver subpar treatment procedures.

There were many technologies combined for various referral systems. Among them, this research focused on optimal resources and technology use and delivered an effective referral service among hospital physicians and laboratories. In this paper, a web-based application as frontend, database management, file storage, local server, and real-time notification services will be discussed.

The future sections of this paper are structured as follows: Section **ii** discusses an outline of related work, which presents comprehensions from previous studies on referral systems in the healthcare sector using different technologies. Section **iii** provides the materials and methodology used in various sections, such as requirement gathering, system architecture and technologies, Frontend development, Backend development and data management approaches. Section **iv** discusses results and discussion. Finally, the paper concludes in section **v** by summarizing the study's key findings, limitations, and future work.

II. Related Work

The study by Shephard et al.(2018) [2] investigates the deployment of an electronic referral (e-referral) system to enhance interspecialty patient referrals both effectively and safely within hospital settings. The hospital's paper-based referral system was considered ineffective and unsafe regarding patient care. The implementation of this e-referral system shortened the entire referral process from start to finish. The e-referral system demonstrates better patient safety alongside enhanced user experience and contains functions which enable specialties to confirm receipt of referrals and monitor treatment progress. All referrals within the system create a permanent storage that allows complete audit tracking for

inpatient referrals. An examination of the project showed that converting paper-based referral process into electronic format produces better efficiency combined with improved patient safety outcomes. Several disadvantages are associated with this research study. The collected data from this setup lacked statistical significance because fewer subjects participated voluntarily and the hospital had limited patient numbers. This data collection method may result in inconclusive findings about the referral system's impact. The researcher should have obtained qualitative data through questionnaires instead of face-to-face interviews to boost the strength of the findings. The procedure of referral timing evaluation relied on basic measurement methods to assess a complicated healthcare process.

This paper (Palliyaguru, 2020) [1] details work on creating an automated patient history registration system for multiple healthcare facilities. The system aims to advance healthcare service quality through immediate access to patient health records. The system combines pharmacy and laboratory functions with patient registration along with doctor participation into one integrated platform, enabling physicians to observe complete patient histories. The system enables doctors to monitor complete patient information, which includes their complete medical background. Through mobile devices along with computers, patients gain access to their medical records

University of California San Francisco established an electronic referral solution (e-referral) alongside San Francisco General Hospital, according to the publication by Straus et al. (2011) [3]. The e-Referral system demonstrates its purpose to enhance communication within the referral process between primary care providers and specialist doctors but also resolves existing referral systems problems. As a HIPAA-compliant web-based system with Electronic Health Record integration, the e-referral platform enables smooth data exchange while preserving current workflow processes. The system facilitates iterative communication between PCPs and specialists. PCP users can submit e-referral requests through electronic systems before specialist reviewers review them. Prior acceptability studies demonstrated PCP approval levels at 71.9% regarding e-referral benefits for clinical care. While all medical services use policy pages for referral requirements, specialist clinics employ screening questions for proper referral routing. Bellandante health systems enable specialist reviewers to reach out to referring providers by phone or email to discuss patient concerns. The e-referral system enabled successful referral tracking according to 89.0% of users, while 73.0% of users felt pre-visit work-ups benefited from e-referral over traditional paper referrals. Less avoidable specialty surgical follow-up appointments occurred after PCPs started using the e-referral system.

The research conducted by Pratama et al. [4] at X Hospital demonstrates how web-based systems create opportunities for healthcare organizations to enhance their patient management and service delivery process. The system, which runs on PHP and CodeIgniter 4 framework, enables patients to conduct remote registration followed by service choice and data submission through an online interface. Such a methodology proves suitable for designing hospital referral solutions that decrease the need for physical transactions. The system delivers better information accessibility because patients can browse available clinics with scheduled doctors through an online interface. The Waterfall model would serve as a basis for building a referral system through its planning phase followed by design, then implementation and testing before maintenance services. This system meets hospital accreditation standards, which cuts down waiting periods and enhances both service delivery quality and patient satisfaction levels. Web-based systems demonstrate great potential to transform healthcare environments according to the study, while the research fails to investigate essential requirements, which include laboratory data integration and inter-provider message management.

Digital transformation in healthcare has been a significant strategy to improve efficiency and sustainability, particularly in hospital referrals. The review by Frago-Marques and Ozben [5] on digital transformation and sustainability in healthcare and clinical laboratories highlights how digital tools can optimize resource use and improve service delivery. They argue that digital transformation can reduce waste and enhance service effectiveness, as seen in Greece's e-prescription and e-referral system during the COVID-19 pandemic. This could be applied to hospital referral systems, where transitioning from paper-based to digital methods could minimize delays and resource consumption. Digital health interventions, such as telemedicine and tele-laboratory services, can expedite the communication of test requests and results, enabling faster decision-making and reducing patient waiting times. System integration is crucial for the success of digital transformation, as seen in the UK's Patients Know Best platform and Greece's National Reporting Business Intelligence System. Telehealth can reduce carbon emissions by minimizing commutes, but digitalization introduces challenges, such as the environmental footprint of ICT infrastructure and the need for robust security to protect health data.

III. Methodology

A. Requirements Gathering

The requirement gathering phase established the first vital stage of web-based hospital laboratory referral system development by determining the requirements for physicians, laboratory technicians and administrators, and patients. The phase focused on the complete identification of requirements for managing referrals and data sharing and safe storage management systems operating within the local network infrastructure. A structured methodology was used for achieving this purpose through initial stakeholder identification steps and subsequent assessment processes. Hospital administrators with oversight responsibilities, physicians writing test prescriptions, laboratory technicians handling test requests and results, as well as IT professionals maintaining LAN systems comprised the main stakeholders for this project. The main goal focused on connecting the gap between existing paper-based referral processes to digital solutions due to the identification of testing

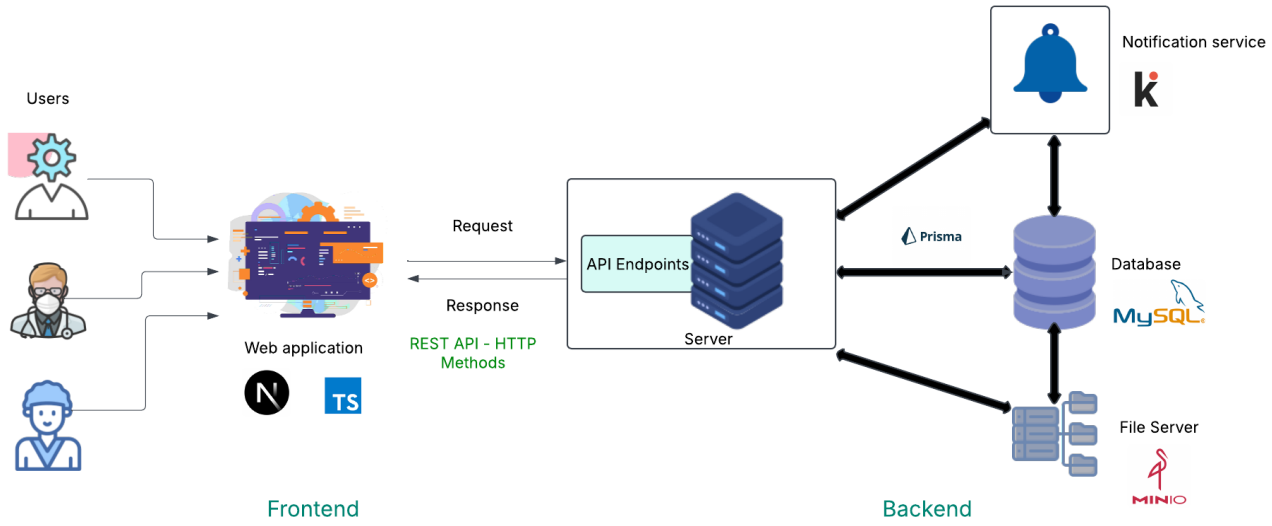

Fig. 1: System Architecture Diagram

outcome delays and patient data inaccuracies that appeared in the project's introduction section.

B. System Architecture and Technologies

An architecture framework of the web-based hospital laboratory referral system keeps all interactions and data management procedures smooth between physicians and laboratory technicians, and hospital administrators. The system functions as a client-server network through a local area network (LAN), which provides secure and reliable data communication according to the architecture diagram. User interactions occur on the front-end system; therefore, the backend component deals with data handling and storage functions together with notification procedures.

TABLE I: Technologies used to implementation

Component	Technology
Frontend development	Next.js, Typescript
Backend development	Node.js
Database system	MySQL
Database Interaction	Prisma ORM
File server	MinIO
Notification Service	Knock

C. Frontend Development

The user interface delivered by the frontend section enables interaction between administrators, doctors and lab technicians according to the left portion of the architecture diagram. Next.js as a React framework and TypeScript in its foundation allows developers to build a web application that delivers quick response and reliable type-safety thus creating superior performance and sustainability. The user-interactive interface consists of forms utilized for managing user accounts as well as patient information and laboratory report uploads through the frontend component. A web browser enables users to start system actions by creating referrals along with medical record assessments and testing results monitoring. API endpoints within the backend function through RESTful design using HTTP methods including GET, POST, PUT, DELETE to exchange data with the frontend. This secure communication pipeline maintains the transmission of user data including referral submissions to the backend servers for processing at the same time it sends test result notifications back to the user interface in real time.

D. Backend Development

The system backend fulfills its role by processing data and storing information and by providing notification services to deliver dependable and secure functionalities. API endpoints accessible through the server establish RESTful HTTP communication to connect the backend with the frontend part of the system. Node.js serves as the likely framework for this server since Next.js and TypeScript indicate its implementation to process requests that store patient data and retrieve test results while managing referrals. MySQL database handles the data storage element by creating a structured data format. The backend uses Prisma ORM for operating on databases through APIs because this Object-Relational Mapper provides an abstraction layer to execute database queries and manipulations efficiently. The system provides secure file storage through MinIO which functions as a high-performance object storage solution to store medical reports locally to satisfy data security requirements. A real-time notification system developed by Knock provides the backend with dynamic webpage alerts through its service which automatically delivers new test outcome messages and referral notification updates to users. The system has implemented three security measures which include role-based access control (RBAC) together with bcrypt password encryption and JWT token-based session

management. [6] The MySQL database on the Apache server benefits from both environmental variables and controlled database credential access to secure the medical data against unauthorized entry.

E. Data Management

A web-based hospital laboratory referral system employs a thorough data management approach to handle patient and referral information efficiently, thus enabling better diagnostic outcomes and better operational performance in a hospital laboratory environment. A hospital laboratory referral system handles patient and referral data through four primary aspects: data acquisition, information storage with retrieval functions and data evaluation, visualization methods and security standards. Each segment utilizes specialized tools to solve the problems of handling sensitive medical information in the local network.

- Data Collection

The system enables data entry through web-based forms, which allow different user groups such as administrators doctors and lab technicians to interact with the system. The platform uses forms to help administers maintain accounts together with patient information and laboratory document uploading. User data registration for the `api/users` endpoint functions by receiving JSON payloads that incorporate first_name along with last_name as well as mobile and email and password and role fields to validate before database storage. The system accepts patient data through forms by obtaining medical history and test prescription information, which lab technicians utilize forms to submit test results that are transmitted to backend RESTful API endpoints for data storage. [7]

- Data Storing and Retrieving

All patient and user and referral-related data is structured within a MySQL database that functions as the main storage repository for complete datasets. The Prisma ORM (Object-Relational Mapper) system creates a simplified connection between the backend and MySQL database that operates through APIs. In the `api/users` endpoint endpoint's codebase the database operations are shown through POST that applies a `prisma.user.create` command for new user insertions in MySQL while GET fetches all users along with their associated roles through `prisma.user.findMany`. Prisma's type-safe query functionality increases both system reliability along with maintenance capabilities. The Prisma platform enables the backend server to extract data from the MySQL database efficiently thus permitting smooth access to medical history records and test outcomes. The PDF report storage system uses MinIO to maintain local secure storage for unstructured medical data at the facility level.

- Data Analysis and Visualization

The integration of data analysis and visualization allows hospitals to obtain actionable insights through which their staff can examine referral patterns and patient success metrics properly. The MySQL database provides raw data to APIs that transform it into acceptable formats for visualization as line charts, bar charts and tables along with pie charts. Using the application doctors can gain access to referral status summaries along with test result trend data along with patient counts and test type distributions as well as laboratory information and test referral frequencies per test type categorizations and gender and age-specific patient enrollment charts.

- Data Security

The system contains data security as a fundamental requirement because medical records demand high levels of protection. RBAC functions as the access control method that grants users the privilege to see only the data connected to their roles—for doctors, it is patients' records, while lab technicians upload test results and administrators manage patient information. User role validation occurs when the `api/users` endpoint checks the role field against the database entry (`prisma.role.findUnique`) before establishing user-role ID connections. The code implements bcrypt encryption for password storage by running `bcrypt.hash(password, 10)` before saving user data due to its ability to prevent clear text storage of confidential credentials. All User sessions start after login with JWT to generate access tokens that authenticate subsequent server calls safely. The MySQL database, protected by the Apache server, benefits from controlled data access combined with environmental variables employed to secure database credentials, which decreases unauthorized access risks. MinIO serves as a storage solution for medical reports, providing security protection for unstructured data. [8]

IV. Results and Discussion

The important outcomes from implementing the system form the core of this section, which covers data collection interfaces, a dashboard page alongside patient and referral tables, and database ER diagrams. These outcomes are evaluated in the context of the project's objectives, such as improving data management and user interaction.

A. Data Collection Interfaces

The implemented forms helped collect data from users, patients and submit referrals and test results between doctors and specific laboratories.

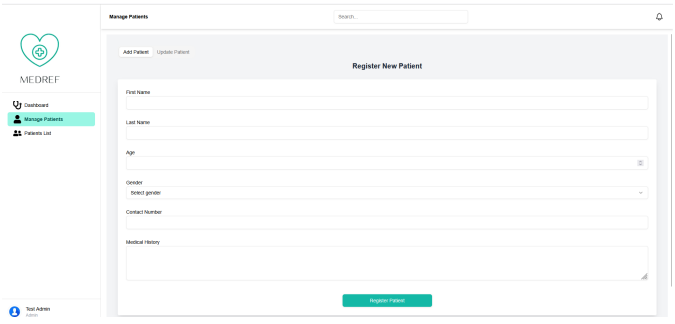

Fig. 2: Patient Registration Form

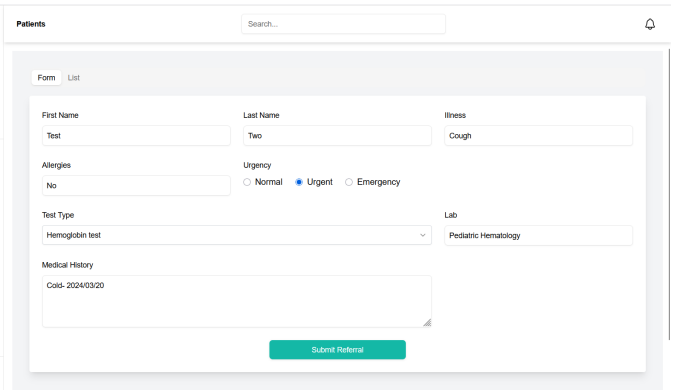

Fig. 3: Referral Submission Form

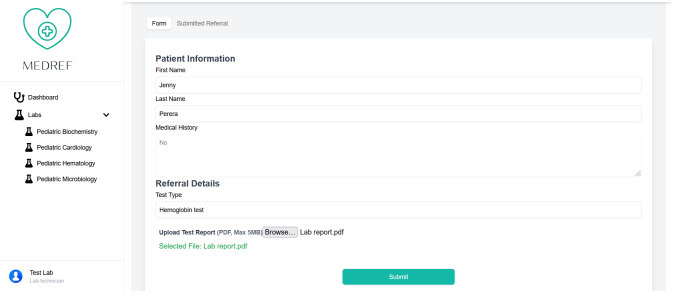

Fig. 4: Test Results Submission Form

B. Data Storing and Retrieving

Relational databases are used to store data in a structured manner.

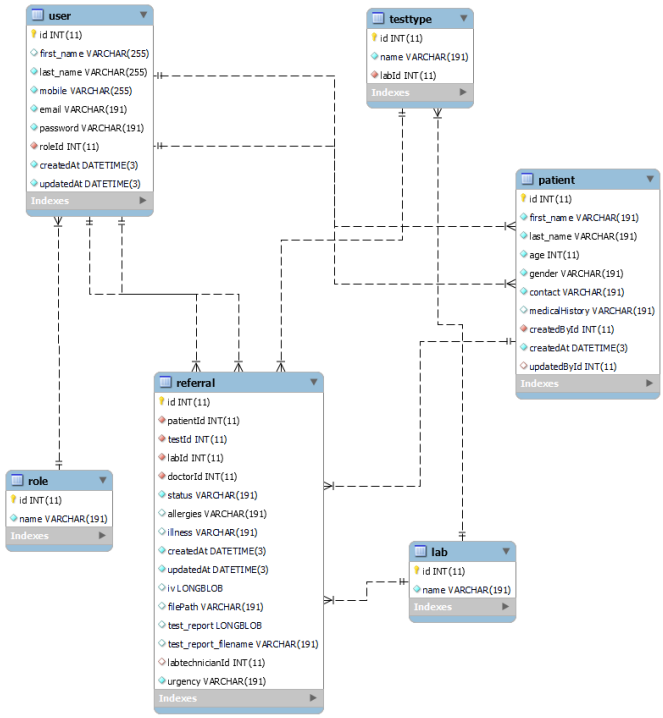

Fig. 5: Database Schema

C. Data Analysis and Visualization

The following dashboard and tables show how this referral system is involved in data analysis and visualization. The dashboard is available for all three users to get more insights about patient data and referrals in the system.

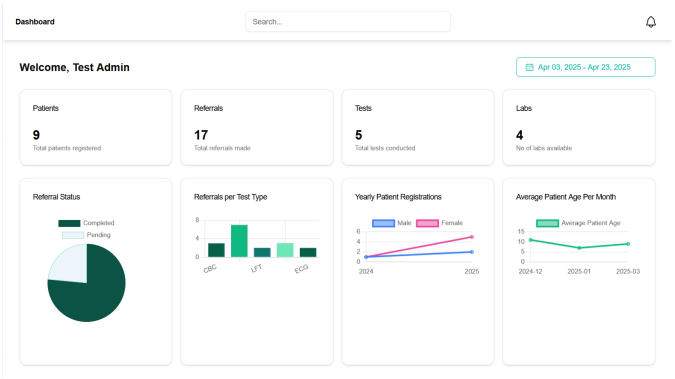

Fig. 6: Analytical Dashboard

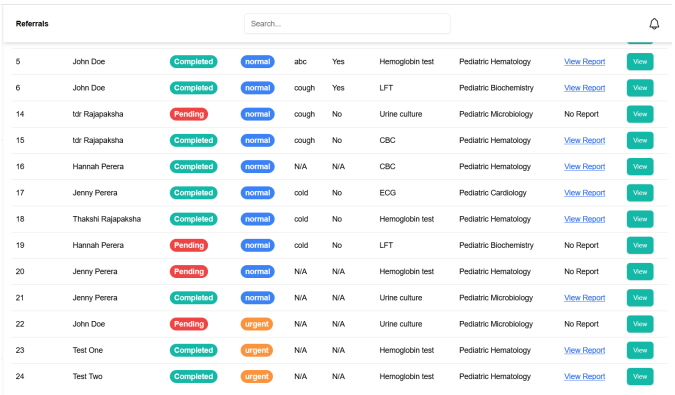

Fig. 7: Referrals Table

D. Data Security

The role-based access to specific profiles is done by using a sign-up page, login page including password encryption, and JWT Tokens, which ensure the data security of this referral system. Furthermore, the MinIO server supports secure medical report storage.

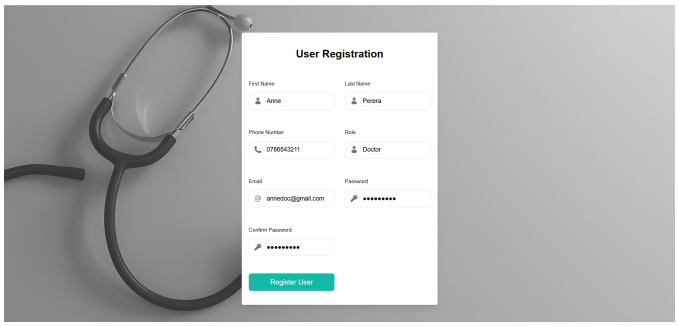

Fig. 8: Role Based User Registration

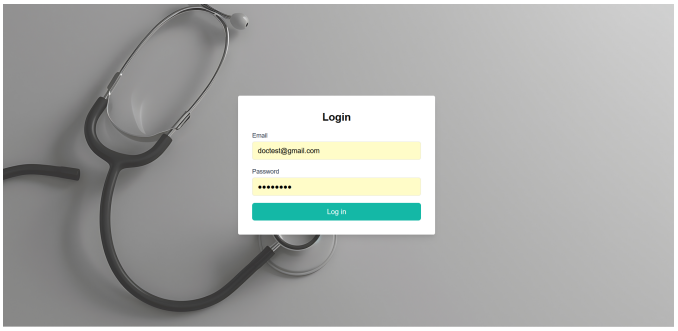

Fig. 9: User Login

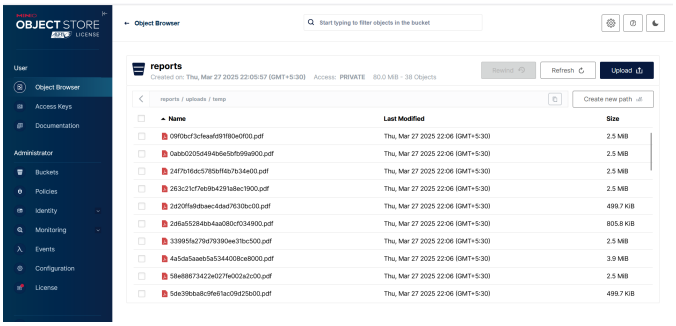

Fig. 10: MinIO file storage

According to above results, the hospital laboratory referral process benefits from effective data management support because it ensures proper organization of data both during collection and storage as well as its analysis and protected format. The system uses MySQL with Prisma ORM and patient and referral tables and user-interactive forms to manage data effectively for digital paper-free referral management. The system upholds its strength in data consistency through a properly designed ER schema together with robust security features, including RBAC and bcrypt encryption for safeguarding sensitive medical information.

V. Conclusion

The study developed a web-based hospital laboratory referral system that optimized referral activities through improved data management and improved communication and better system accessibility. The system contains databases organized within MySQL while using user-interactive forms in addition to structured dashboards and patient tables. Real-time referral tracking as well as operational efficiency improvements, accompany diagnostic accuracy growth because of the system's data security features. The development of the project encountered multiple obstacles during construction, particularly in the areas of user interface design, database performance optimization for massive datasets, entity data fidelity protection, RBAC security protocols, and constrained scalability from its dependence on a local network infrastructure.

Moreover, the system will receive future updates that involve visual insights technology along with real-time push notifications while implementing automated prioritization for urgent referrals as well as local server deployment with reverse proxy functionality for testing across multiple devices. The system enhancements strive to enhance decision processes while improving user interaction with additional features that ensure better scalability and load management capabilities, creating a dependable solution for laboratory referral organizations in hospitals.

References

[1] S. M. Palliyaguru, "Automated patient history registration system for asiri group of hospitals," m.s. thesis, University of Colombo School of Computing, Colombo, Sri Lanka, 2020.

[2] E. Shephard, C. Stockdale, F. May, A. Brown, H. Lewis, S. Jabri, D. Robertson, V. Moss, and R. Bethune, "E-referrals: Improving the routine interspecialty inpatient referral system," 2018. Accessed: 2025-04-01.

[3] S. G. Straus, A. H. Chen, H. F. Y. Jr., M. B. Kushel, and D. S. Bell, "Implementation of an electronic referral system for outpatient specialty care," *Journal of the American Medical Informatics Association*, vol. 18, pp. 1337–1346, Sep./Oct. 2011.

[4] M. R. Pratama *et al.*, "The implementation of web-based patient registration system at x hospital," *Atlantis Press*, Feb. 2022. Accessed: 2022-09-16.

[5] M. Fragão-Marques and T. Ozben, "Digital transformation and sustainability in healthcare and clinical laboratories," *Clinical Chemistry and Laboratory Medicine*, vol. 0, Dec. 2022.

[6] J. Hummel, "The washington health record bank: Patient-centered health information exchange," in *Health Information Security and Collaboration National Conference*, (Maryland), March 4 2009.

[7] A. Dogac and G. Laleci, "The use of HL7 CDA in the national health information system of turkey," *Journal of Healthcare Information Management*, vol. 22, no. 3, pp. 10–15, 2008.

[8] K. M. McDonald, V. Sundaram, D. M. Bravata, R. Lewis, N. Lin, S. A. Kraft, M. McKinnon, H. Paguntalan, and D. K. Owens, "Measures of patient safety based on hospital administrative data - the patient safety indicators," Technical Reviews 5, Agency for Healthcare Research and Quality (US), 2002.