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SQLearn: Smart Information Sharing System

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Abstract

Students and laboratory users at technical institutions often encounter difficulties accessing comprehensive details on laboratory equipment and learning materials, as traditional physical tags provide only minimal identification. SQLearn: Smart Information Sharing System addresses this challenge by establishing a web-based, QR-code-driven information platform designed to centralize access to digital instructional resources. Each physical QR code links directly to dynamic digital pages containing equipment specifications, operating manuals, safety guidelines, reference images, and video tutorials. Developed using HTML5, CSS3, JavaScript, Node.js, and Firebase Realtime Database, the system enables quick information retrieval via standard device cameras without requiring dedicated mobile applications. Preliminary functional testing confirms that the prototype successfully scans generated QR codes, routes users to dedicated resource pages, and enables real-time administrative content updates. SQLearn offers a practical solution for simplifying information access and centralizing laboratory resource management across campus facilities.

Keywords; QR code; information sharing; smart learning; web-based system; cloud database.

Introduction

Students in the Civil Engineering and Woodwork laboratories at Politeknik Ungku Omar often experience delays when retrieving detailed operational procedures, technical specifications, and safety documentation for equipment. Most laboratory machinery features basic physical tags or serial numbers, which do not supply sufficient operational guidance or safety instructions (Wahyuni, S., Lubis, A., Ferbina, A., & Purba, B., 2023). To address this information gap, this project presents SQLearn, a web-based information sharing system that leverages Quick Response (QR) code technology to deliver quick, localized access to digital documentation (Cordova, 2011). By scanning a QR code mounted on laboratory equipment using a standard mobile device camera (Wahyuni et al., 2023), users can view technical descriptions, downloadable PDF user manuals, safety protocols, and embedded tutorial videos. Authorized administrators can manage, edit, and append content centrally via a secure dashboard, ensuring that resource pages remain accurate and up to date. SQLearn aims to streamline laboratory information distribution and support self-guided resource access within technical learning environments.

Methodology

SQLearn was developed using an Agile software development model, facilitating iterative refinement across system design, database architecture, and user interface modules (Senarath, 2021; Tetteh, 2024). The development lifecycle encompassed requirement analysis, wireframing in Figma, frontend and backend implementation in Visual Studio Code, and cloud database integration.

Technology Stack & Implementation

- **Frontend Interface:** Built using standard HTML5, CSS3, and JavaScript, providing a responsive interface for mobile and desktop web browsers.
- **Backend Framework:** Developed with Node.js and Express.js to handle application routing and server-side request processing.
- **Cloud Database & Storage:** Integrated with Firebase Realtime Database for instantaneous content synchronization and Firebase Cloud Storage for hosting PDF manuals, images, and video assets.

- **QR Interfacing:** QR codes are generated dynamically using client-side JavaScript rendering libraries and encoded with unique resource URLs (Raju et al., 2024). Camera-based scanning utilizes the browser-native HTML5 Canvas and WebRTC APIs.

System Testing

System verification was conducted in two phases:

1. **Functional Testing:** Verified core capabilities including administrator authentication, equipment resource record creation, dynamic QR code rendering, direct URL routing, and cloud asset retrieval.
2. **Preliminary Compatibility Testing:** Evaluated system rendering and QR response rates across mainstream web browsers (Google Chrome, Mozilla Firefox, Safari) on iOS and Android smartphones.

Results and Discussion

The initial functional implementation of SQLearn has been completed, resulting in a fully operational web application prototype connected to Firebase cloud services.

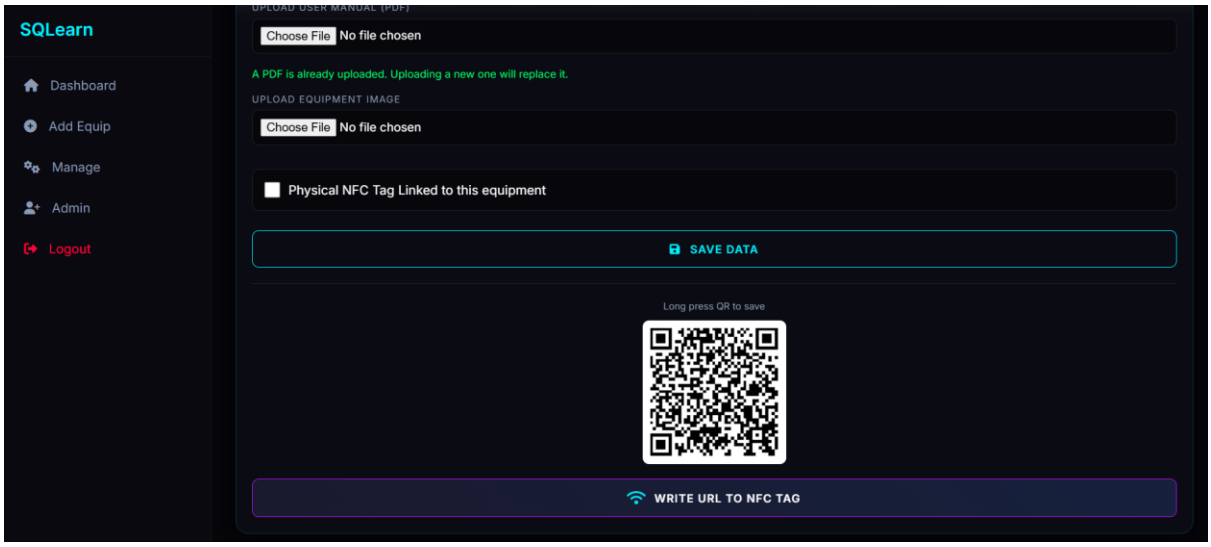


Figure 1: SQLearn administrative dashboard and resource creation interface

As shown in Figure 1, the administrative dashboard allows authorized staff to input equipment metadata, upload associated documentation (PDFs and images), generate corresponding dynamic QR codes, and optionally write asset URLs directly. Table 1 summarizes the functional testing outcomes, in which all three tested functions passed.

Table 1. Functional Testing of SQLearn

Variable / Trial	Measure 1	Measure 2	Outcome
QR code scanning	Scan a valid QR code using a mobile device camera	Correct SQLearn information page opens	Passed
Information retrieval	Open a linked equipment/information record	Relevant text, images, manuals or videos are displayed	Passed
Admin content management	Authorized admin creates or updates a record	Changes are saved and reflected on the information page	Passed

Discussion and System Limitations

Preliminary testing indicates that SQLearn simplifies the process of retrieving laboratory resource materials by eliminating manual web searching. Centralized cloud hosting enables administrators to maintain current documentation across all connected physical assets without re-printing tags.

Several operational limitations were identified during initial testing:

- Network Connectivity: Real-time data retrieval relies on active internet access; offline caching strategies are required to support low-connectivity areas.
- Physical Tag Maintenance: QR code readability depends on ambient lighting conditions and physical tag condition (e.g., cleanliness or surface scratches).
- Evaluation Scope: While technical functionality is verified, formal user studies measuring perceived usability and long-term impacts on learning efficiency remain subject to future user acceptance testing (UAT).

Conclusion

SQLearn: Smart Information Sharing System is proposed to improve the way students, lecturers, and laboratory users access equipment information and learning resources. SQLearn presents a functional, cloud-connected information management prototype designed to bridge physical laboratory resources with digital documentation via QR codes. By leveraging HTML5, Node.js, and Firebase, the platform enables instantaneous access to equipment specifications, manuals, and multimedia tutorials directly from mobile web browsers. Preliminary testing confirmed successful system operation across QR generation, routing, media retrieval, and administrator content management. Future developments will focus on introducing offline resource caching, expanding user access role management, incorporating usage analytics for laboratory equipment, and conducting formal usability evaluations with students and instructional staff.

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