Laboratory Swipe Tracking and Reporting System(ILAB)

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Abstract

This report presents the design and implementation of a Microsoft Access-based Laboratory Swipe Tracking and Reporting System developed for managing laboratory and cleanroom equipment usage. The system provides a structured workflow for user identification, equipment check-in and check-out, account number association, session tracking, receipt generation, administrative user management, and usage reporting. The application was designed to support shared instrumentation environments where accurate records of equipment access, user activity, session duration, and billing-related information are essential.

The system uses a card-swipe workflow to identify users and determine whether they are beginning or ending an equipment usage session. During check-in, the user selects the appropriate account and instrument, and the system records the session start. During check-out, the system closes the active session, calculates duration, and generates a receipt. Administrative users can manage user records, view usage reports, apply date-range filters, and export report data for further review. The implementation emphasizes reliability, workflow clarity, maintainability, and compatibility with existing laboratory operations.

This report describes the motivation, system requirements, architecture, database design, workflow logic, administrative features, reporting functionality, testing approach, limitations, and future improvements of the Laboratory Swipe Tracking and Reporting System.

Keywords: Microsoft Access, laboratory management, equipment usage tracking, swipe system, session management, reporting, user management, audit logging.

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1. Introduction

Shared laboratory and cleanroom facilities require accurate and consistent tracking of equipment usage. In these environments, multiple users may access different instruments under different accounts, projects, or billing categories. For administrative and operational purposes, it is necessary to know which user accessed an instrument, when the session began, when it ended, how long the instrument was used, and which account should be associated with the session.

Manual or partially automated tracking methods can introduce several challenges. Users may forget to record their session information, enter inconsistent account details, or fail to sign out after using equipment. Administrators may then need to reconstruct usage history, resolve incomplete records, or manually prepare billing reports. These issues can affect the reliability of operational data and increase the administrative workload associated with shared instrumentation management.

The objective of this project was to develop a practical software system that centralizes laboratory equipment usage tracking in a single application. The resulting system, implemented in Microsoft Access, provides a swipe-based interface for laboratory users and an administrative interface for managing users and reports. Microsoft Access was selected because it supports integrated forms, tables, queries, reports, and VBA-based automation, making it suitable for a controlled laboratory desktop environment.

The system is intended to support day-to-day laboratory operations by simplifying the user workflow while preserving the data needed for administrative review. A user interacts primarily with a swipe interface, while administrators access reporting, user management, and application control features through a separate dashboard. This separation of roles allows the system to remain simple for general users while still providing the functionality required for management and reporting.

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2. Project Objectives

The project was designed to meet the following objectives:

1. Provide a reliable card-swipe workflow for laboratory equipment check-in and check-out.
2. Associate each usage session with a registered user, account number, selected instrument, start time, end time, and calculated duration.
3. Generate receipts after check-in and check-out events to confirm session activity.
4. Provide an administrative dashboard for user management, reporting, and application control.
5. Support date-range-based usage reports for operational and billing review.
6. Allow report data to be exported to Excel for external analysis and record keeping.
7. Support kiosk-style operation so that normal users interact only with the intended swipe workflow.
8. Preserve compatibility with existing laboratory data and workflows.

These objectives guided both the database design and the user interface structure. The system was built to prioritize accuracy, usability, and maintainability rather than unnecessary complexity.

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3. System Overview

The Laboratory Swipe Tracking and Reporting System consists of four primary modules: the swipe interface, session management logic, administrative dashboard, and reporting module.

The swipe interface is the main user-facing component. It captures card swipe input, identifies the user, and directs the workflow based on whether the user has an active session. If no active session exists, the system initiates the check-in workflow. If an active session exists, the system initiates the check-out workflow.

The session management logic controls how records are created, updated, and closed. It ensures that each usage session contains the correct user, account number, equipment selection, check-in time, check-out time, and duration. This logic is central to the reliability of the system because reporting depends on complete and accurate session records.

The administrative dashboard provides access to management functions. Administrators can open reports, manage users, return the application to the swipe screen, and exit the system when necessary. This module separates administrative functionality from the regular user workflow.

The reporting module provides structured views of laboratory activity. Reports can be filtered by date range and exported to Excel. This allows administrators to review usage patterns, support billing processes, and maintain operational records.

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4. System Architecture

The application is implemented as a Microsoft Access database application using relational tables, forms, queries, reports, and VBA procedures.

The architecture follows a form-driven workflow. Users and administrators interact with Access forms rather than directly modifying database tables. Forms provide controlled data entry, workflow navigation, and validation. Queries retrieve and filter the data required by reports and administrative views. Reports present usage information in a formatted structure suitable for review and export. VBA procedures coordinate the application logic, including user identification, session creation, session closure, receipt display, navigation, and startup behavior.

At a high level, the system follows this sequence:

1. The user swipes a card at the kiosk interface.
2. The system identifies the corresponding user record.
3. The system checks whether the user currently has an active session.
4. If no active session exists, the user is guided through account and equipment selection.
5. The system creates a new usage record and stores the check-in time.
6. If an active session exists, the system records the check-out time and calculates the session duration.

7. A receipt is displayed to confirm the transaction.
8. The system returns to the initial swipe screen for the next user.
9. Administrative users can later review and export usage records through the reporting module.

This architecture keeps the workflow deterministic and minimizes the number of actions required from the user.

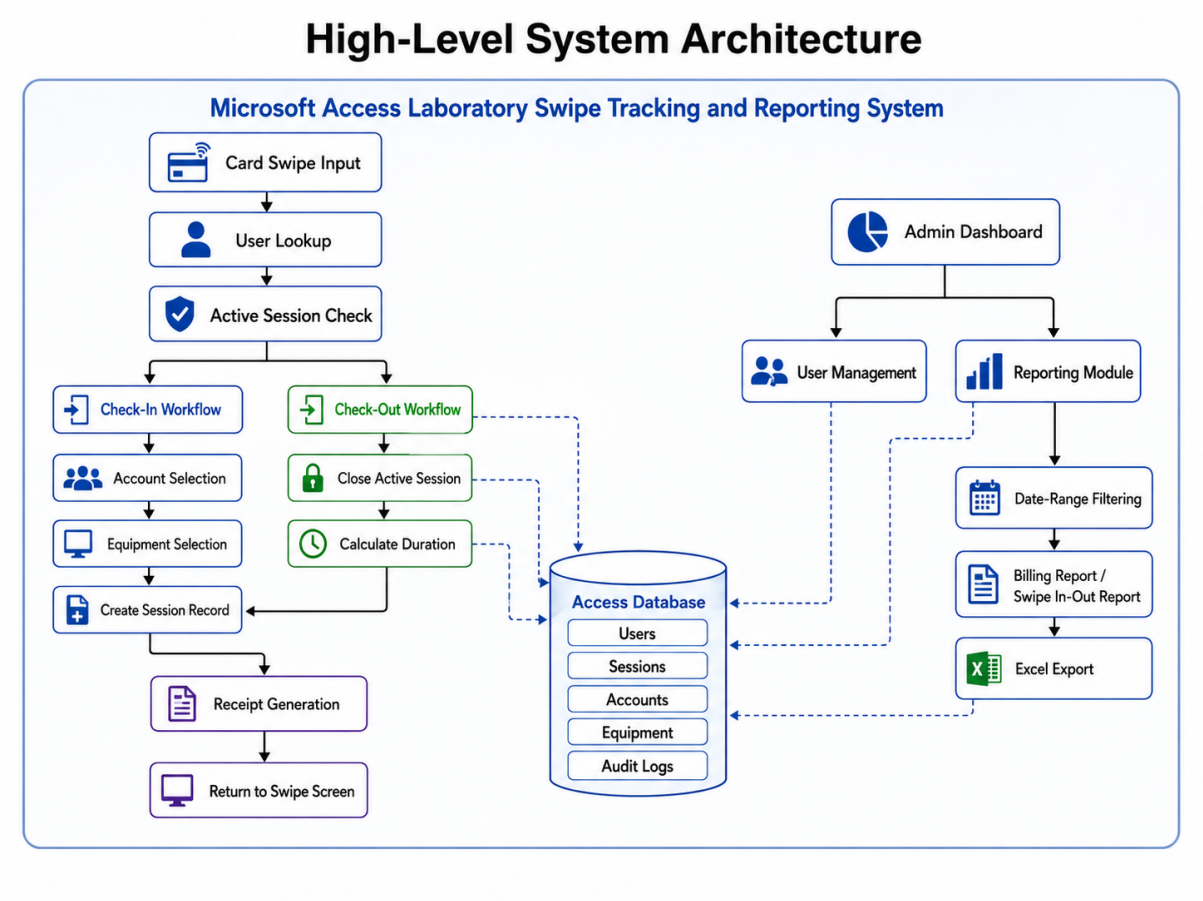

Figure 1. High-level architecture of the Laboratory Swipe Tracking and Reporting System.

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5. Database Design

The database stores the core information required for laboratory usage tracking. The main data categories include user records, card identifiers, account information, instrument selections, usage sessions, audit-related activity, and reporting data.

User records support card-based identification. Each user must be associated with the information needed to recognize them when a card is swiped. Accurate user records are essential because all session activity depends on correct user identification.

Usage session records represent equipment access events. A session begins when a user checks in and ends when the user checks out. Each session stores the selected account

number, selected equipment, check-in timestamp, check-out timestamp, duration, and any additional comments or status information.

Equipment information allows the system to classify usage by instrument. The tracked instrument list includes Atomic Layer Deposition, E-Beam Evaporator, E-Beam Lithography, Etcher, Focused Ion Beam, Furnace, Mask Aligner, and Sputtering Decomposition. Maintaining consistent instrument naming across forms, stored records, receipts, and reports is important for accurate reporting.

Account information connects usage activity to the appropriate billing or research account. This enables administrators to review equipment usage by account and produce reports that support operational or financial workflows.

The database structure is designed to support active session detection, historical reporting, receipt generation, and administrative review without requiring users to interact directly with underlying tables.

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6. User Workflow

The user workflow is designed for simplicity and reliability.

When a laboratory user approaches the system, the swipe screen is presented as the main interface. The user swipes their card, and the system retrieves the corresponding user record. The next step depends on the user’s current session status.

If the user does not have an active session, the system begins check-in. The user selects an account number and the instrument being used. After confirmation, the system creates a new session record and stores the check-in time. A receipt is displayed to confirm that the session has started.

If the user already has an active session, the system begins check-out. The active session is retrieved, the check-out time is recorded, and the duration is calculated. A receipt is displayed to confirm that the session has ended.

After the receipt is displayed, the interface returns to the initial swipe screen. This reset behavior is important because the system is intended for shared use by many laboratory users.

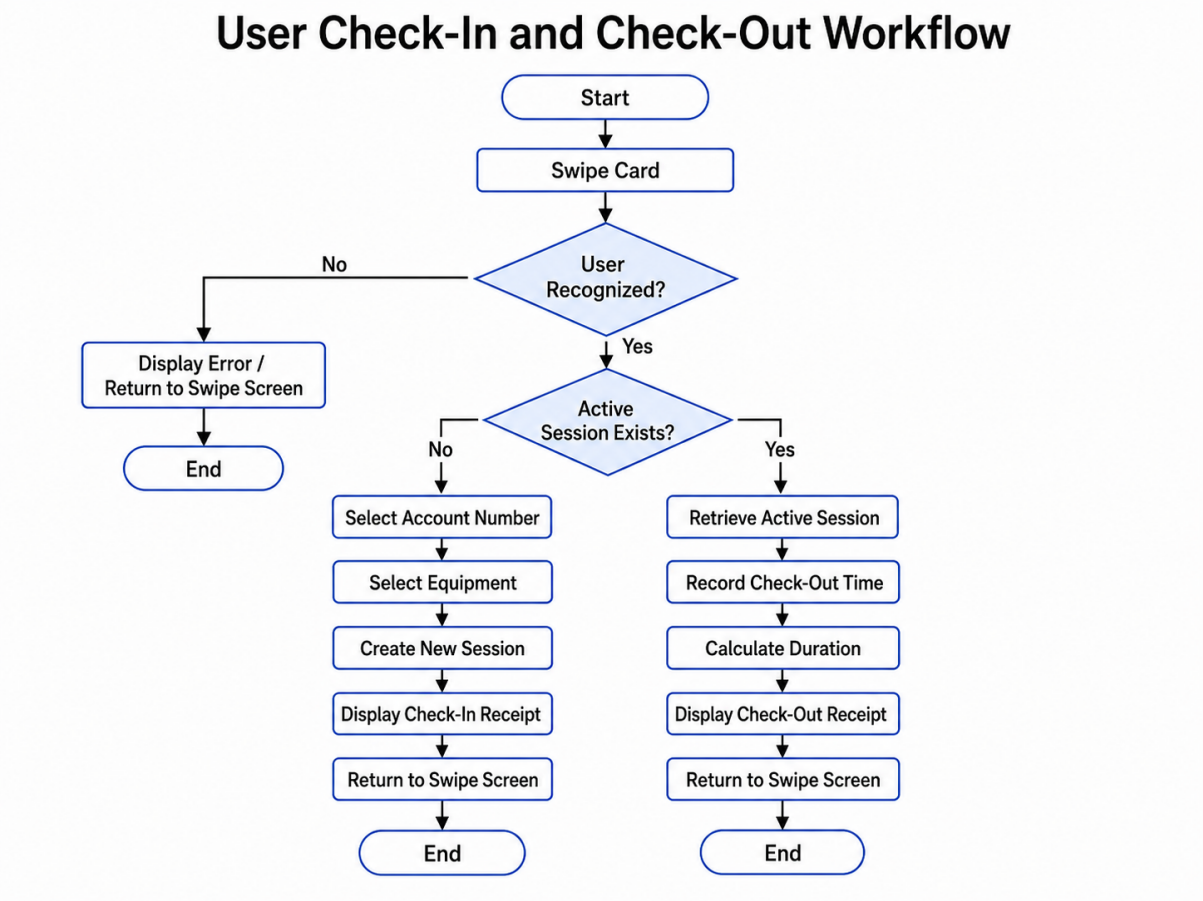

Figure 2. User check-in and check-out workflow used for laboratory equipment session management.

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7. Receipt Generation

Receipt generation provides immediate confirmation of user activity. Receipts are displayed after check-in, check-out, and exceptional session-handling events such as forgotten swipe-out workflows.

A receipt summarizes the key information associated with the session, including the user name, selected account, selected equipment, check-in time, check-out time when available, duration when available, and any relevant comments. This confirmation helps users verify that their session was recorded correctly.

The receipt display is also part of the user experience design. It gives users enough time to review the transaction before the system returns to the initial swipe screen. This supports kiosk-style operation by automatically preparing the application for the next user.

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8. Administrative Dashboard

The administrative dashboard provides controlled access to system management functions. It allows administrators to access reports, manage user records, return to the swipe interface, and exit the application.

The dashboard is separated from the regular user workflow to reduce the risk of accidental changes and to keep the main swipe process simple. Laboratory users interact with the swipe interface, while administrators use the dashboard to perform management and review tasks.

This design supports role separation within the application. General users complete operational tasks, while administrators maintain the system and review data.

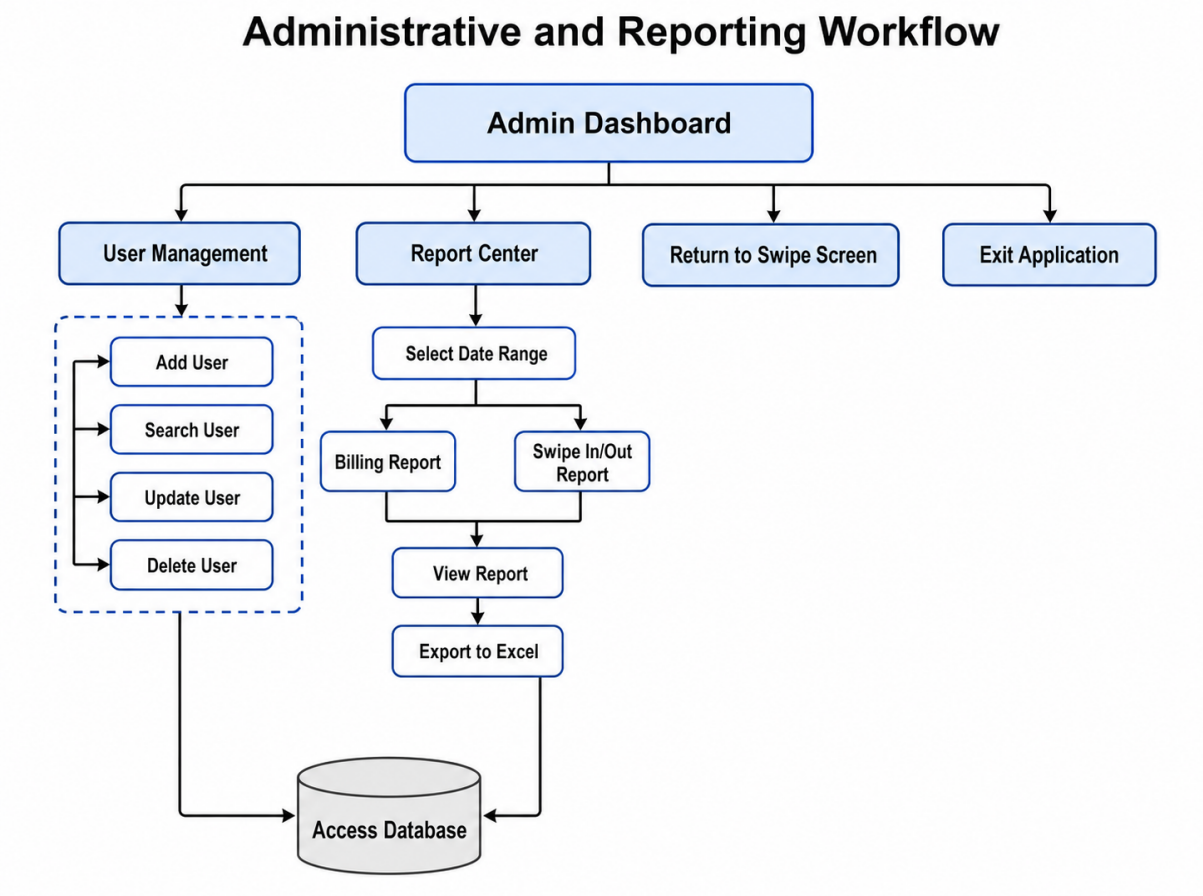

Figure 3. Administrative and reporting workflow supporting user management and report generation.

9. User Management

The user management module allows administrators to maintain the user records required for swipe recognition and session tracking. Administrators can add new users, search for existing users, modify user information, delete users, and navigate through user records.

This module is important because the accuracy of the system depends on current and correct user data. If a user's card identifier, name, account association, or access information is incorrect, the system may fail to identify the user or may record the session inaccurately.

By providing user management through Access forms, the system avoids requiring administrators to edit database tables directly. This improves usability and reduces the risk of accidental structural changes.

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10. Reporting Module

The reporting module supports administrative review of laboratory activity. The system provides billing reports and swipe in/out reports. These reports allow administrators to review usage over selected date ranges and export the results to Excel.

Billing reports support account-based review of equipment usage. Swipe in/out reports support operational review of user activity and session timing. Together, these reports provide a structured view of how laboratory instruments are being used.

Date-range filtering allows administrators to focus on a specific period, such as a billing cycle, academic term, or operational review window. Excel export allows report data to be shared, archived, or analyzed outside the Access application.

The reporting module is a critical part of the system because it converts stored session records into useful administrative information.

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11. Kiosk Operation

The system is designed to support kiosk-style use. In normal operation, the database opens directly to the swipe screen. This reduces the chance that laboratory users will interact with internal database objects or administrative areas.

Kiosk operation improves usability by presenting a focused interface. Users do not need to understand the database structure or navigate through Microsoft Access menus. They only need to swipe, select required session information, and confirm the transaction.

For maintenance and recovery, administrators can bypass startup behavior when necessary. This allows the system to remain usable in a controlled environment while still permitting design access for authorized maintenance.

12. Implementation Approach

The implementation was guided by the principle of operational reliability. Since the system is intended for real laboratory use, the design avoids unnecessary complexity and focuses on preserving stable workflows.

The application logic is implemented through VBA procedures connected to Access forms and controls. These procedures handle card input, user lookup, session status checks, account and equipment selection, record creation, record updates, duration calculation, receipt display, and navigation.

The system also uses Access reports for formatted output and queries for retrieving filtered data. This approach takes advantage of native Microsoft Access capabilities while adding custom workflow logic where needed.

A major design consideration was backward compatibility. The system must preserve existing records and continue supporting established laboratory procedures. Therefore, future changes should be targeted and carefully tested rather than implemented as large rewrites.

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13. Testing and Validation

Testing focused on verifying the main operational workflows and administrative functions.

The check-in workflow was tested by swiping a registered user card, selecting an account number, selecting equipment, creating a session, and confirming receipt output.

The check-out workflow was tested by swiping a user card with an active session, closing the session, recording check-out time, calculating duration, and confirming receipt output.

The reporting workflow was tested by generating usage reports over selected date ranges and verifying that the displayed data matched stored session records. Excel export was tested to ensure that administrators could retrieve report data outside the application.

User management was tested by creating, searching, updating, and deleting user records. These tests verified that administrative functions supported the data required by the swipe workflow.

Validation also included review of equipment naming consistency, session completion behavior, and return-to-swipe-screen behavior after receipt display.

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14. Limitations

The system is designed for a controlled Microsoft Access environment and is not intended to replace a large-scale enterprise laboratory information management system. Access is practical for local deployment and integrated reporting, but it may require additional planning if the number of users, records, or concurrent access needs increase significantly.

The system also depends on accurate administrative data. User records, account numbers, card identifiers, and equipment names must be maintained properly for the workflow to remain reliable.

Another limitation is that kiosk behavior and report display behavior are constrained by Microsoft Access interface behavior. The system can provide a focused user experience, but some Access-level interface elements may require careful configuration to avoid disrupting report viewing or navigation.

Finally, the system requires continued administrative oversight for exceptional cases such as missed check-outs, incorrect account selections, or user record changes.

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15. Future Work

Future improvements can strengthen reliability, maintainability, and administrative control.

One improvement is to enhance validation around account and equipment selection so that incorrect or incomplete session information is minimized. Another improvement is to provide clearer administrative tools for reviewing and resolving incomplete sessions.

The reporting module could be expanded with additional summary views, such as usage by instrument, usage by account, total duration by user, and monthly billing summaries. These additions would make the system more useful for long-term operational planning.

The system could also benefit from stronger role-based access control for administrative features, automated backup procedures, and more detailed audit review tools.

If usage grows beyond the practical limits of Microsoft Access, a future version could migrate the backend to a more scalable database while preserving the same swipe-based workflow for users.

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16. Conclusion

This project developed a Microsoft Access-based Laboratory Swipe Tracking and Reporting System for managing shared laboratory and cleanroom equipment usage. The system

provides a structured workflow for card-based user identification, equipment check-in and check-out, account association, session tracking, receipt generation, user management, reporting, and Excel export.

The project addresses a practical operational need: maintaining accurate and accessible records of laboratory equipment usage. By combining a simplified user-facing swipe interface with administrative reporting and management tools, the system supports both daily laboratory activity and longer-term administrative review.

The primary contribution of the project is a functional, maintainable application that improves the reliability of laboratory usage tracking while remaining suitable for a controlled desktop environment. The system provides a foundation for accurate session management, billing support, and operational reporting, with clear opportunities for future improvement in validation, reporting depth, access control, and scalability.

The completed system demonstrates how a lightweight database-driven application can be used to support real-world laboratory operations. By integrating user authentication, equipment tracking, session management, reporting, and administrative controls into a single platform, the system provides a practical and maintainable solution for shared instrumentation environments.

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