International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

LabAssist: Optimized Science Laboratory Management System with Data Analytics for South East Asian Institute of Technology, Inc.

Prof. Hernan E. Trillano Jr.

MIT College of Information and Communication Technology
South East Asian Institute of Technology, Inc., Tupi, South Cotabato, Philippines 9505
hernantrilla@gmail.com

Abstract

The South East Asian Institute of Technology, Inc. faced challenges in managing science laboratory operations, including inefficient inventory tracking and borrowing processes. LabAssist: Optimized Science Laboratory Management System with Data Analytics was developed to address these issues. The system incorporated features such as Borrowing and Returning, Inventory Management, Penalty Tracking, and an Analytic Dashboard for decision-making. Following Agile Methodology, the system was iteratively enhanced based on testing and feedback.

The System Usability Scale (SUS) evaluation yielded a high average score of 86.67, confirming the system's usability and effectiveness. Science Lab Admins and Faculty Borrowers rated the system highly for functionality and ease of use, while Student Borrowers provided positive feedback, highlighting the need for further familiarity. All modules functioned as designed, streamlining laboratory processes and improving resource accessibility. LabAssist has demonstrated its capacity to optimize laboratory management and enhance user satisfaction.

Keywords: Laboratory Management, Inventory Tracking, Data Analytics.

1. Introduction

Efficiency is essential for optimal operations, particularly in science laboratories where accurate and timely management is crucial. At South East Asian Institute of Technology, Inc., the lack of a management system has led to operational inefficiencies, including challenges in tracking borrowers, managing due dates, generating reports, and maintaining inventory. Manual processes hinder workflow, causing delays, resource misallocation, and increased maintenance costs.

To address these issues, the researcher developed a system to automate laboratory operations. By digitizing key processes such as borrower management, inventory tracking, and transaction reporting, the proposed solution aims to minimize errors and enhance efficiency. Automation ensures resources are readily available, reduces disruptions, and allows staff to focus on critical tasks. Studies affirm the effectiveness of digital tools in improving operational efficiency and resource management. [1], [2]. This

system offers a simplified approach to laboratory management, meeting the demands of modern workflows while improving overall functionality.

2. Review of related literature

A. Data Analytics and Workflow Optimization

Data analytics is crucial for optimizing science laboratories, particularly exceptionally minimal—and medium-sized labs. It transforms raw data into actionable insights that enhance operational efficiency and resource allocation. [3]. Real-time analytics enable laboratories to efficiently manage larger datasets and optimize their operational workflows even in data-heavy environments. [4].

[5] Implementing data analytics enables laboratories to identify inefficiencies in workflows, ultimately improving sample processing times and inventory management.

B. Data Analytics for Inventory Control in Labs

The adoption of lab inventory management software represents a significant advancement in the operational efficiency of research laboratories. By transitioning from traditional paper-based tracking to a digital platform, laboratories achieve a simplified approach to inventory control. This shift enhances inventory management, making monitoring stock levels easier, setting up reorder alerts, and informing everyone in the lab. Lab inventory management simplifies inventory processes, reduces errors, and supports better organization and productivity in research activities.[6].

[7]This report provides a broad industry analysis of how the Laboratory can enhance laboratory efficiency, mainly through improved inventory control and data management integrated with data analytics. However, the report briefly touches on user experience, even though many LIMS systems are too complex for non-technical staff to use effectively. [8] Highlighted how data analytics tools help simplify inventory management by tracking reagent usage and expiry dates, which prevents stockouts or wastage. Additionally, [9] Pointed out that visualization tools that display real-time inventory levels and sample status reduce the risk of operational delays due to low stocks. They concluded that laboratories using LIMS with embedded data analytics experience fewer delays and improved inventory accuracy.

C. Visualizations for Data Representation

A performance dashboard is an active visualization of data and an analysis tool adequately used to present the critical key performance indicators through various visualizations. These enable data exploration directly with filters and drill-down capabilities. [10].

Performance dashboards have advantages, such as the ability to evaluate large amounts of data, demonstrate results in an easy-to-interpret layout, provide notifications of metrics that deviate from predefined acceptable levels to reduce adverse events, provide decision-making assistance to improve efficiency and quality, and bring data-based decision-making to executive management.[11]

Additionally, it emphasizes the role of data visualization in enhancing laboratory informatics by identifying operational inefficiencies, optimizing workflows, and improving the tracking of critical metrics like turnaround times and inventory levels. This study discusses how visual dashboards represent

lab data, allowing managers to make informed decisions quickly.[12] Moreover, Data visualizations can help people understand data, gain insight, answer specific questions, and discover underlying facts.

3. Methodology

A. Agile Model

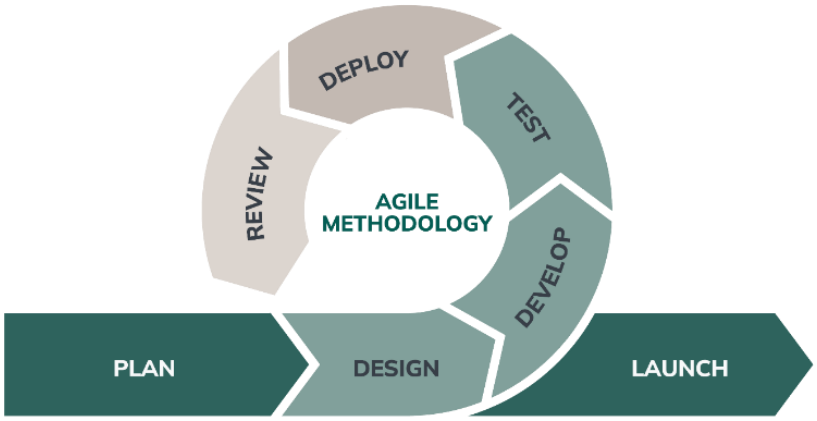


Fig. 1. Agile Model

The Agile Model, known for its iterative and incremental approach, was employed to develop the LabAssist: Optimized Science Laboratory Management System. This model is particularly effective for projects requiring continuous feedback and refinement. Each sprint involved a series of specific activities aimed at progressively building the system. In the planning phase, requirements were gathered through interviews and observations at the South East Asian Institute of Technology, Inc., identifying the key features such as borrowing, inventory, and analytics modules. The design phase involved creating wireframes and system workflows to ensure user-friendliness and alignment with stakeholder needs. During development, the core functionalities, including SMS notifications, equipment tracking, and reporting tools, were incrementally coded and integrated. Testing was conducted at Norala National High School using real-world scenarios to validate functionality and usability. Feedback was collected during the review phase to refine features and address issues. The system was deployed in a controlled environment for further validation before the final launch. Documentation and training were provided to ensure the system's successful adoption and usability. This iterative approach allowed the system to evolve through each sprint, ensuring it met the operational and user requirements effectively.

4. Conceptual framework of the study

A. System Design

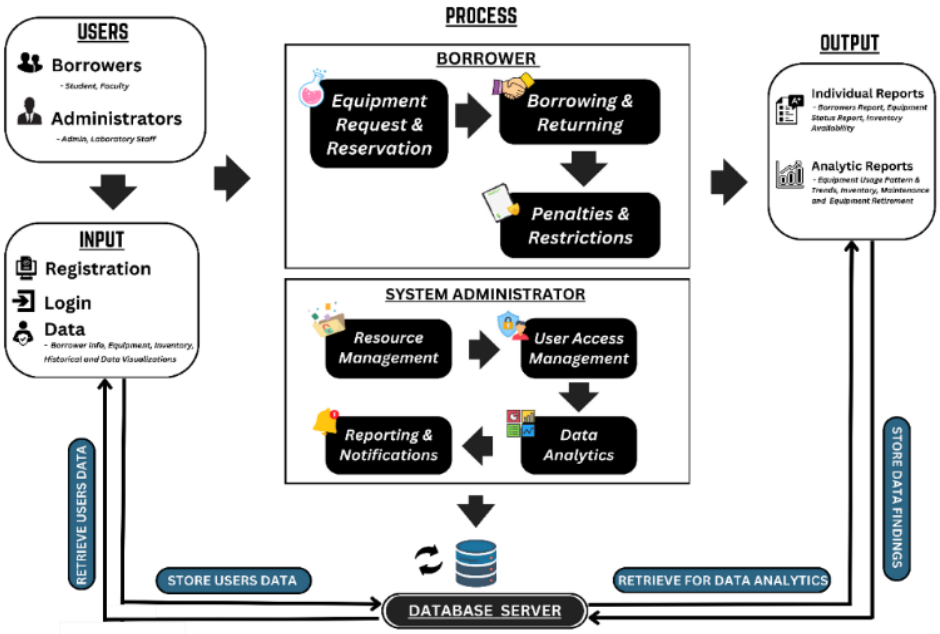


Fig. 2. Conceptual Framework of the Study

Figure 2 shows the conceptual framework of the LabAssist: Optimized Science Laboratory Management System, outlining the workflow between users, input, processes, and outputs to streamline science laboratory operations. The framework identifies two primary user groups: Borrowers, including researchers, students, and faculty, who utilize the system for equipment requests, reservations, and borrowing; and Administrators, comprising technicians and laboratory staff, responsible for managing resources and overseeing system processes. The input includes registration and login data for user authentication and data such as borrower information, equipment inventory, and historical and current analytics. The processes are divided based on user roles: Borrower processes encompass equipment request and reservation, borrowing and returning, and penalties and restrictions to ensure accountability, while Administrator processes include resource management, user access management, reporting and notifications, and data analytics for operational optimization. The system outputs both individual reports, such as borrower and equipment status, and analytic reports, offering insights into demand forecasting, usage trends, and maintenance planning. A centralized database server supports all operations by storing and retrieving data for real-time analytics and system functions.

The framework reflects the study's objectives: to develop an automated system that addresses inefficiencies in laboratory operations, enhances resource accessibility, and reduces errors through data analytics and comprehensive reporting. The system aims to improve equipment availability, simplify borrowing and returning processes, and provide reliable insights for informed decision-making, ultimately optimizing laboratory management at the South East Asian Institute of Technology, Inc.

B. System Design

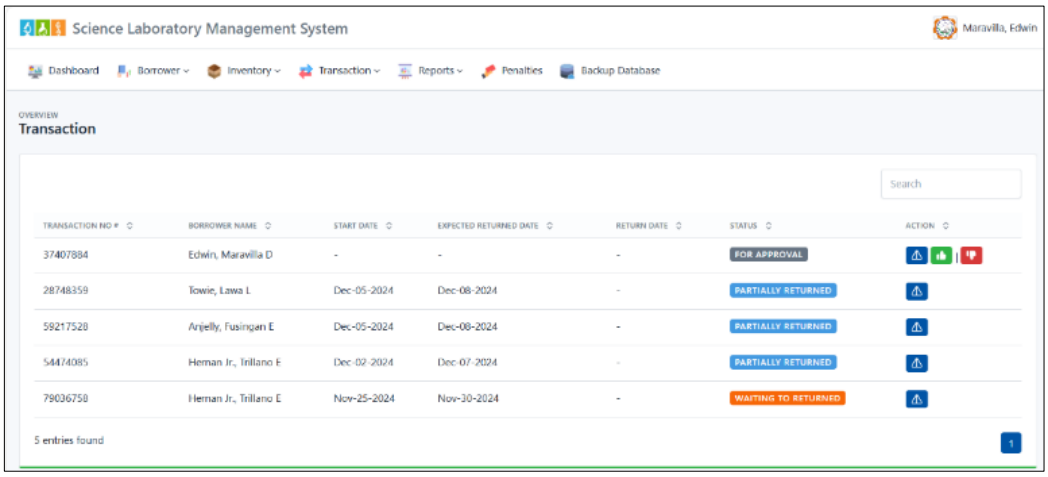


Fig. 3. Borrowing and Returning Module

Figure 3 illustrates the borrowing and returning module under the transaction section, summarizing ongoing transactions requiring admin actions.

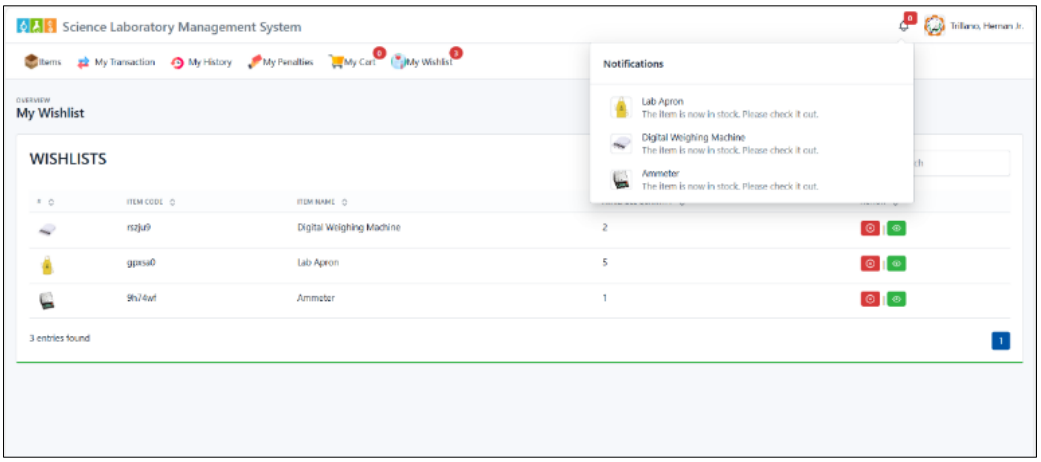


Fig. 4. Equipment Reservation Module

Figure 4 enables borrowers to organize and review their selected items for potential borrowing, streamlining the preparation process before submitting a formal request.

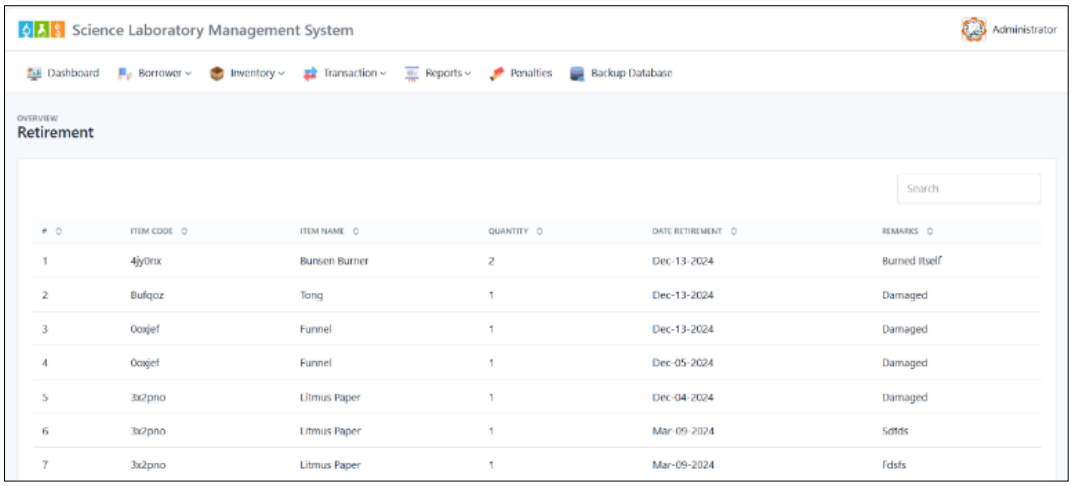


Fig. 5. Equipment Retirement Module

Figure 5 illustrates the Item Retirement page under the Inventory section, where the admin can retire items that are either damaged or returned with damages.

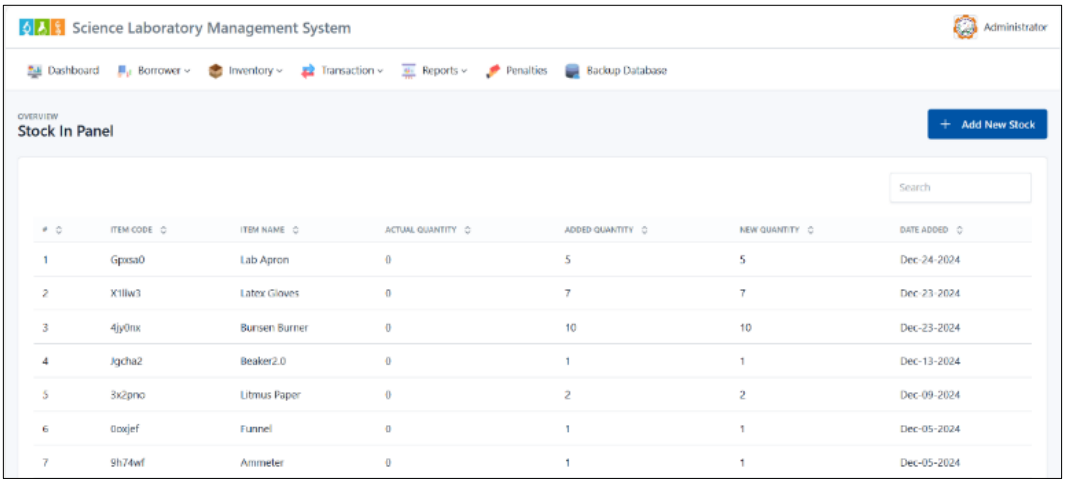


Fig. 6. Stock – In Module

Figure 6 displays the Stock In page under the Inventory section, where the admin can add and update stock quantities for laboratory apparatus and equipment.

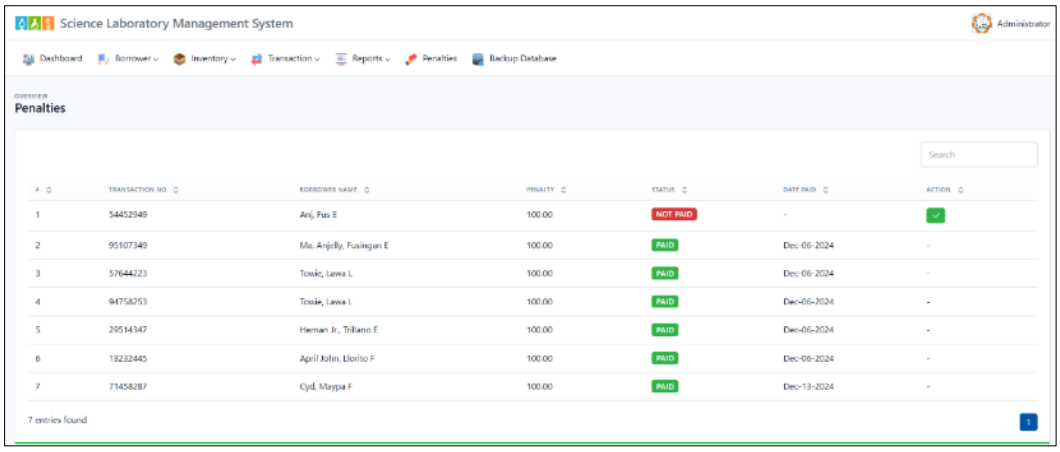


Fig. 7. Penalty Management Module

Figure 7 shows the Penalty Panel, where all penalized borrowers are listed. The interface displays essential details such as the transaction ID, borrower's name, penalty amount, the status indicating whether the penalty has been paid, and the date the penalty was paid.

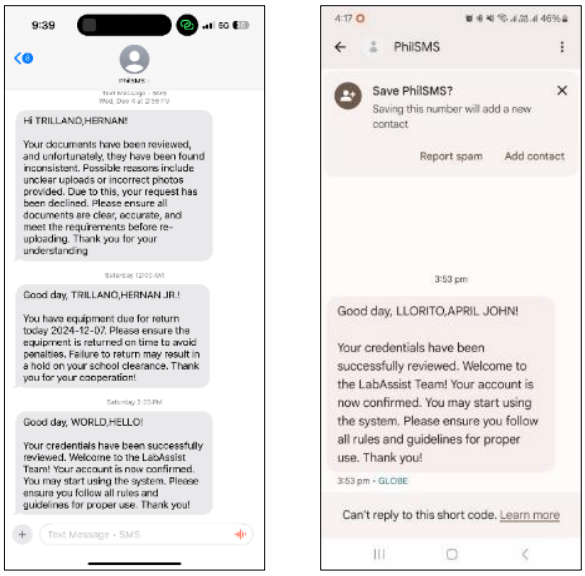


Fig. 8. SMS Notification

Figure 8 depicts the SMS notification module, which enables borrowers to receive SMS notifications regarding registration updates, transaction rejections, and due dates.

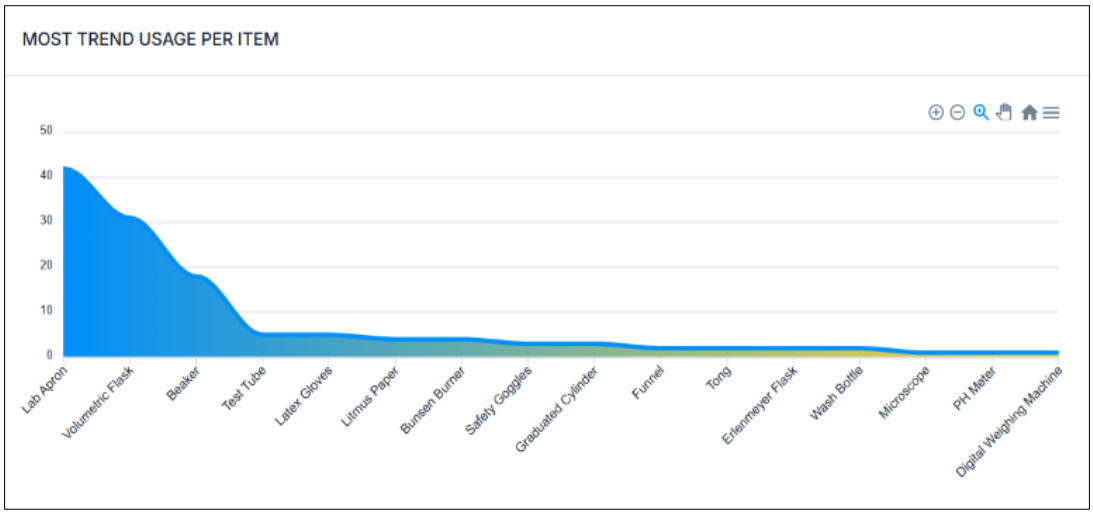


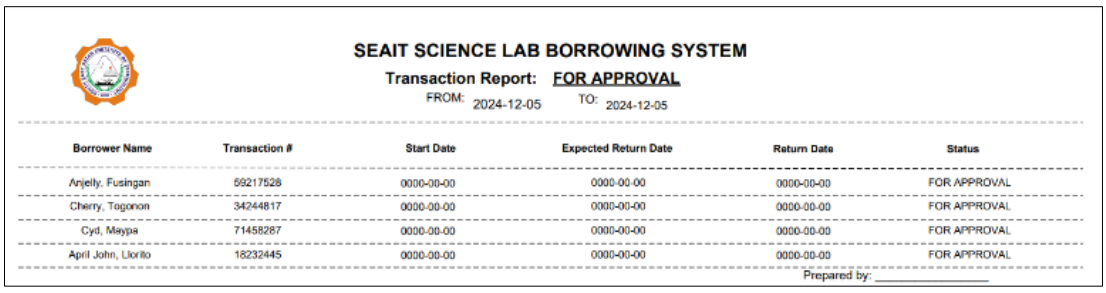
Fig. 9. Equipment Usage Trend – Data Analytics

Figure 9 illustrates the trend analytics of item usage, highlighting the most trending items. This feature supports decision-making by identifying items that should be prioritized for restocking.

Fig. 10. Equipment Stocks Report – Data Analytics

Figure 10 presents the stock levels, highlighting the latest stock-in transactions and showing equipment with high and low stock quantities.

C. Reports Generated



SEAIT SCIENCE LAB BORROWING SYSTEM

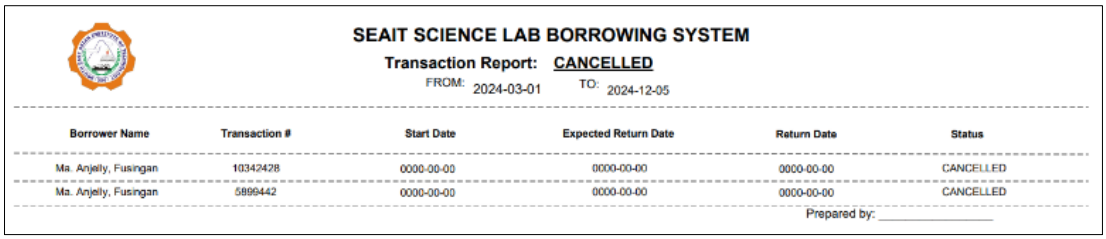
Transaction Report: FOR APPROVAL

FROM: 2024-12-05 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Anjelly, Fusingan	59217528	0000-00-00	0000-00-00	0000-00-00	FOR APPROVAL
Cherry, Togonon	34244817	0000-00-00	0000-00-00	0000-00-00	FOR APPROVAL
Cyd, Maypa	71458287	0000-00-00	0000-00-00	0000-00-00	FOR APPROVAL
April John, Llorito	18232445	0000-00-00	0000-00-00	0000-00-00	FOR APPROVAL

Prepared by: _____

Fig. 11. For Approval Report



SEAIT SCIENCE LAB BORROWING SYSTEM

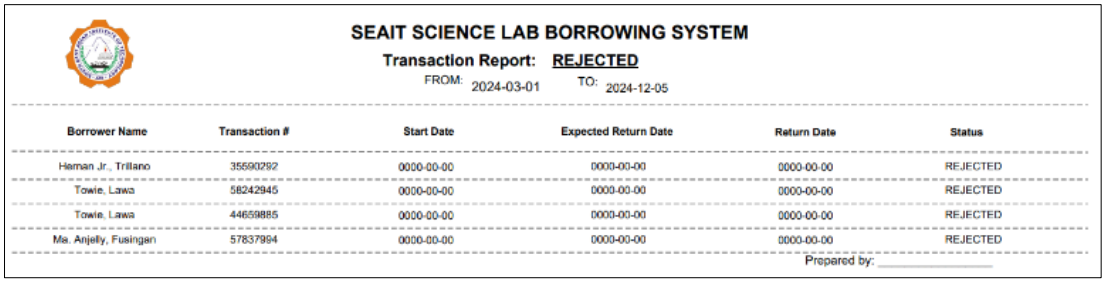
Transaction Report: CANCELLED

FROM: 2024-03-01 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Ma. Anjelly, Fusingan	10342428	0000-00-00	0000-00-00	0000-00-00	CANCELLED
Ma. Anjelly, Fusingan	5899442	0000-00-00	0000-00-00	0000-00-00	CANCELLED

Prepared by: _____

Fig. 12. Cancelled Transaction Report



SEAIT SCIENCE LAB BORROWING SYSTEM

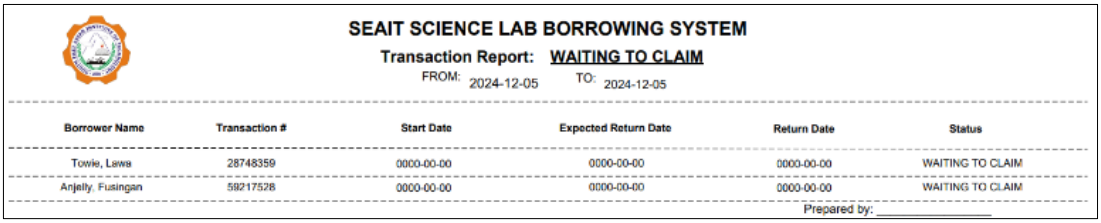
Transaction Report: REJECTED

FROM: 2024-03-01 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Hernan Jr., Trillano	35590292	0000-00-00	0000-00-00	0000-00-00	REJECTED
Towie, Lawa	58242945	0000-00-00	0000-00-00	0000-00-00	REJECTED
Towie, Lawa	44659885	0000-00-00	0000-00-00	0000-00-00	REJECTED
Ma. Anjelly, Fusingan	57837994	0000-00-00	0000-00-00	0000-00-00	REJECTED

Prepared by: _____

Fig. 13. Rejected Transaction Report



SEAIT SCIENCE LAB BORROWING SYSTEM

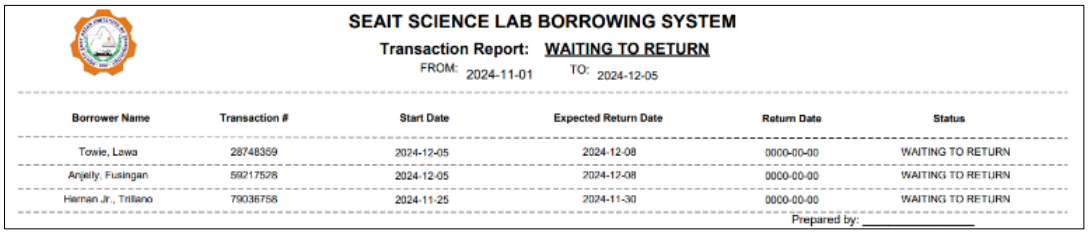
Transaction Report: WAITING TO CLAIM

FROM: 2024-12-05 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Towie, Lawa	28748359	0000-00-00	0000-00-00	0000-00-00	WAITING TO CLAIM
Anjelly, Fusingan	59217528	0000-00-00	0000-00-00	0000-00-00	WAITING TO CLAIM

Prepared by: _____

Fig. 14. Waiting to Claim Report



SEAIT SCIENCE LAB BORROWING SYSTEM

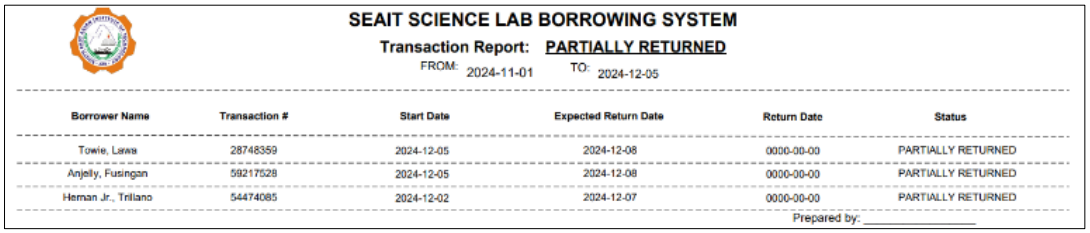
Transaction Report: WAITING TO RETURN

FROM: 2024-11-01 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Towie, Lawa	28748359	2024-12-05	2024-12-08	0000-00-00	WAITING TO RETURN
Anjelly, Fusingan	59217528	2024-12-05	2024-12-08	0000-00-00	WAITING TO RETURN
Hernan Jr., Trillano	79036758	2024-11-25	2024-11-30	0000-00-00	WAITING TO RETURN

Prepared by: _____

Fig. 14. Waiting to Return Report



SEAIT SCIENCE LAB BORROWING SYSTEM

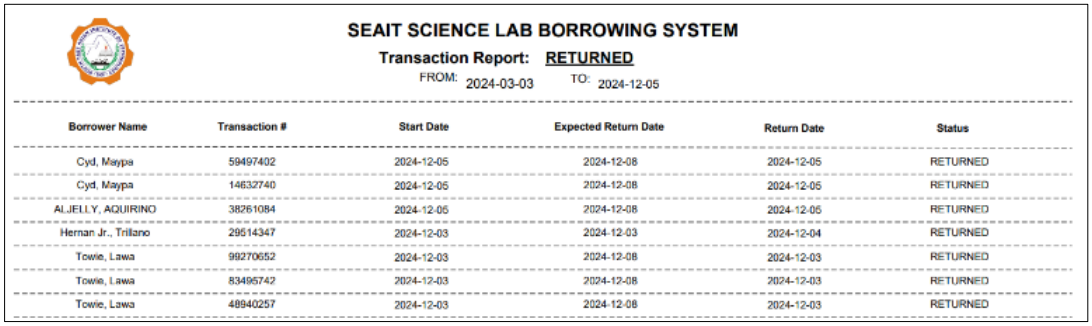
Transaction Report: PARTIALLY RETURNED

FROM: 2024-11-01 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Towie, Lawa	28748359	2024-12-05	2024-12-08	0000-00-00	PARTIALLY RETURNED
Anjelly, Fusingan	59217528	2024-12-05	2024-12-08	0000-00-00	PARTIALLY RETURNED
Hernan Jr., Trillano	54474085	2024-12-02	2024-12-07	0000-00-00	PARTIALLY RETURNED

Prepared by: _____

Fig. 15. Partially Returned Report



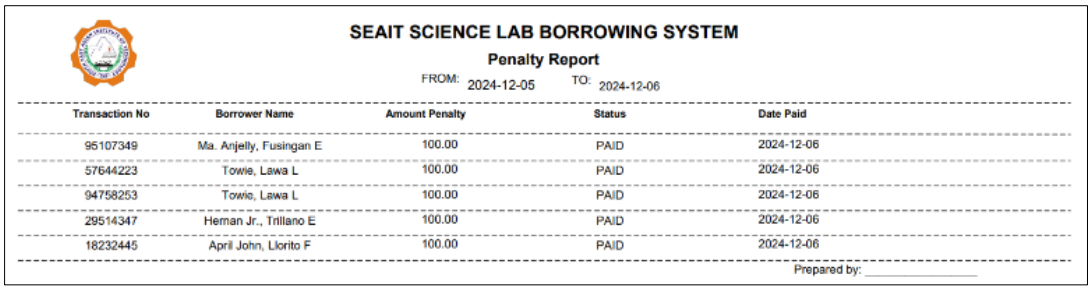
SEAIT SCIENCE LAB BORROWING SYSTEM

Transaction Report: RETURNED

FROM: 2024-03-03 TO: 2024-12-05

Borrower Name	Transaction #	Start Date	Expected Return Date	Return Date	Status
Cyd, Maypa	59497402	2024-12-05	2024-12-08	2024-12-05	RETURNED
Cyd, Maypa	14632740	2024-12-05	2024-12-08	2024-12-05	RETURNED
ALJELLY, AQUIRINO	38261084	2024-12-05	2024-12-08	2024-12-05	RETURNED
Hernan Jr., Trillano	29514347	2024-12-03	2024-12-03	2024-12-04	RETURNED
Towie, Lawa	99270652	2024-12-03	2024-12-08	2024-12-03	RETURNED
Towie, Lawa	83495742	2024-12-03	2024-12-08	2024-12-03	RETURNED
Towie, Lawa	48940257	2024-12-03	2024-12-08	2024-12-03	RETURNED

Fig. 16. Returned Report



SEAIT SCIENCE LAB BORROWING SYSTEM

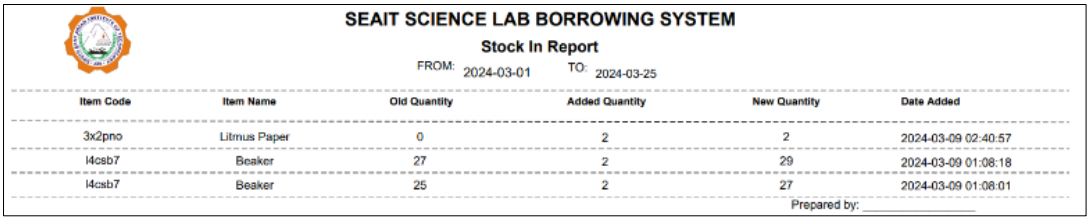
Penalty Report

FROM: 2024-12-05 TO: 2024-12-06

Transaction No	Borrower Name	Amount Penalty	Status	Date Paid
95107349	Ma. Anjelly, Fusingan E	100.00	PAID	2024-12-06
57644223	Towie, Lawa L	100.00	PAID	2024-12-06
94758253	Towie, Lawa L	100.00	PAID	2024-12-06
29514347	Hernan Jr., Trillano E	100.00	PAID	2024-12-06
18232445	April John, Llorito F	100.00	PAID	2024-12-06

Prepared by: _____

Fig. 17. Penalty Report



SEAIT SCIENCE LAB BORROWING SYSTEM

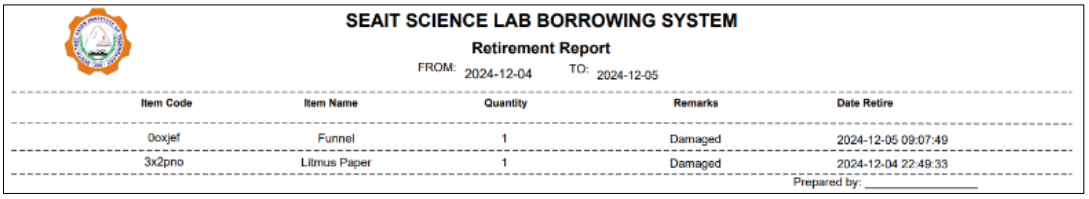
Stock In Report

FROM: 2024-03-01 TO: 2024-03-25

Item Code	Item Name	Old Quantity	Added Quantity	New Quantity	Date Added
3x2pno	Litmus Paper	0	2	2	2024-03-09 02:40:57
l4csb7	Beaker	27	2	29	2024-03-09 01:08:18
l4csb7	Beaker	25	2	27	2024-03-09 01:08:01

Prepared by: _____

Fig. 18. Stock-In Report



SEAIT SCIENCE LAB BORROWING SYSTEM

Retirement Report

FROM: 2024-12-04 TO: 2024-12-05

Item Code	Item Name	Quantity	Remarks	Date Retire
0oxjef	Funnel	1	Damaged	2024-12-05 09:07:49
3x2pno	Litmus Paper	1	Damaged	2024-12-04 22:49:33

Prepared by: _____

Fig. 19. Equipment Retirement Report

5. Results and discussions

A. Development and Testing

The development of LabAssist: Optimized Science Laboratory Management System with Data Analytics was focused on addressing the needs of the South East Asian Institute of Technology, Inc., by simplifying laboratory operations and improving resource management. Key features include borrower account management, inventory control with real-time stock monitoring, penalty tracking, transaction handling for borrowing and returning items, and data analytics. These functionalities aimed to simplify laboratory processes while providing insightful data for better decision-making.

The system was tested to confirm its functionality, feasibility, and ability to meet all objectives during the proposal phase. A 5-point Likert scale evaluation tool, part of the System Usability Scale (SUS), was employed during testing. The testing involved 15 participants from three schools with fully functional wet and dry science laboratories, each equipped with various tools and materials. The participants included five science lab administrators, five science faculty teachers acting as faculty borrowers, and five student borrowers.

B. System Evaluation

The LabAssist: Optimized Science Laboratory Management System was evaluated by three participant groups: Science Lab Admins, Faculty Borrowers, and Student Borrowers. The System Usability Scale (SUS) tool assessed the system's usability, effectiveness, and efficiency. The respondents' scores were ranked from 1 to 5 based on how much they agreed with the statements. A score of 5 indicates

they strongly agree, a score of 4 means they somewhat agree, a score of 3 means neutral, a score of 2 means somewhat disagree, and a score of 1 means strongly disagree. Odd-numbered questions were summed and subtracted by 5 to determine the usability score, while even-numbered questions were subtracted from 25. The final results were multiplied by 2.5 to yield the total SUS score.

The final SUS scores for the participants were as follows: Lab Admins received an average score of 94.00, Faculty Borrowers scored an average of 95.5, and Student Borrowers averaged 70.5. These results indicate that LabAssist is an effective system well-received by administrative and faculty users, who rated it highly for usability and functionality. However, Student Borrowers, while generally positive, indicated that more familiarity with the system would enhance their experience as they were still adjusting to its interface and processes.

The overall mean SUS score across all participants reflects that LabAssist is an acceptable system with high usability. With an average of 86.67, the system is a valuable tool for the South East Asian Institute of Technology, Inc., supporting improved science laboratory management and streamlined borrowing processes.

TABLE 1. RAW RESULTS OF RESPONDENTS ANSWERS IN 5-POINT LIKERT SCALE

SLA – Science Laboratory Admin (5) **BS** – Borrower Student (5) **BF** – Borrower Faculty (5)

Respondent No.	R1	R2	R3	R4	R5	R6
Question	Respondents					
	SLA1	SLB2	SLC3	SLA4	SLA5	BF1
1	5	5	5	5	5	5
2	1	1	1	1	1	1
3	5	5	5	5	5	5
4	1	2	4	1	1	1
5	3	5	5	5	5	5
6	1	1	2	1	1	1
7	4	5	5	5	5	5
8	1	1	1	1	1	1
9	4	5	5	5	5	5
10	2	1	3	1	1	1

Respondent No.	R7	R8	R9	R10	R11	R12
Question	Respondents					
	BF2	BF3	BF4	BF5	BS1	BS2
1	5	5	4	5	3	4
2	1	1	1	1	1	3
3	5	5	5	5	5	5
4	1	1	2	1	3	2
5	5	5	4	5	5	5
6	1	1	2	1	1	2
7	5	5	4	5	5	4
8	1	1	1	1	1	1
9	5	5	4	5	3	4
10	1	1	4	1	5	2

Respondent No.	R13	R14	R15
Question	Respondents		
	BS3	BS4	BS5
1	5	3	4
2	4	5	3
3	5	4	4
4	4	3	4
5	5	5	5
6	1	4	2
7	3	5	5
8	2	1	2
9	3	3	4
10	3	3	3

Table 2 shows all the calculated odd and even scores, which are all based on the raw scores. SUS equation is: (Calculated Odd Score = ((q1 + q3 + q5 + q7 + q9) – 5)). (Calculated Even Score = (25-(q2 + q4 + q6 + q8 + q10)).

QUESTION	SLA1	SLB2	SLC3	SLA4	SLA5	BF1
Odd Score	16	20	20	20	20	20
Even Score	19	19	14	20	20	20

QUESTION	BF2	BF3	BF4	BF5	BS1	BS2
Odd Score	20	20	16	20	16	17
Even Score	20	20	15	20	14	15

QUESTION	BS3	BS4	BS5
Odd Score	16	15	17
Even Score	11	9	11

TABLE II. CALCULATED RESULTS OF ODD AND EVEN NUMBERS

Table 3 shows each respondent's calculated score using the SUS equation for the total SUS score (SUS Score: (Calculated Odd Score + Calculated Even Score) x 2.5 = SUS Score).

Respondents	SUS Score
SLA1	87.5
SLA2	97.5
SLA3	85
SLA4	100
SLA5	100
BF1	100
BF2	100
BF3	100
BF4	75.5
BF5	100
BS1	75
BS2	80
BS3	67.5
BS4	60
BS5	70
Average:	**86.67**

TABLE 4. SYSTEM USABILITY SCALE CALCULATED SCORE AND ACCEPTABILITY SCORE

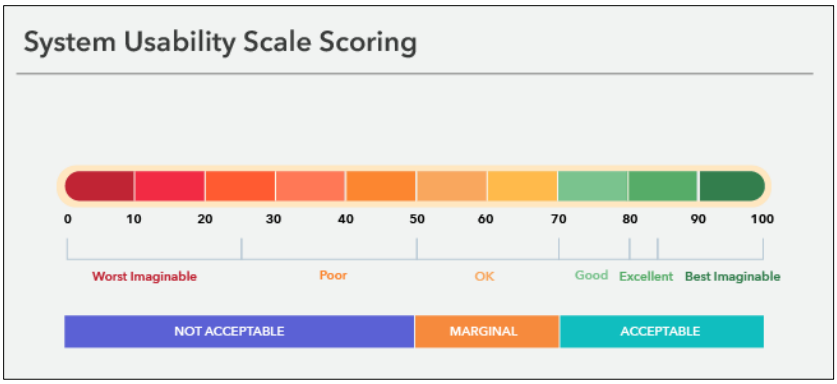


Fig. 20. System Usability Scale

Table 20 shows the overall mean SUS score across all participants, reflecting that LabAssist is an acceptable system with high usability. With an "Excellent" average of 86.67, the system is a valuable tool for the South East Asian Institute of Technology, Inc., supporting improved science laboratory management and simplified borrowing processes.

6. Conclusion

LabAssist: Optimized Science Laboratory Management System with Data Analytics for South East Asian Institute of Technology, Inc. received an overall mean SUS score of 86.67 across all participant groups, reflecting its acceptability as a system with high usability. The system has proven to be a valuable tool for supporting improved science laboratory management and simplifying the borrowing processes effectively.

All features of the system were tested and confirmed to be fully functional, working seamlessly across laboratory transactions, including borrowing, returning, inventory management, and report generation. Respondents found the system to be very useful in simplifying laboratory operations, improving accessibility, and ensuring efficient resource management.

Overall, LabAssist significantly enhanced the management of the science laboratory by providing a highly functional and user-friendly system that effectively met the needs of its stakeholders.

7. Recommendations

Based on the panel reviewers' suggestions, it is recommended that LabAssist: Optimized Science Laboratory Management System with Data Analytics be further enhanced by developing a mobile application version. This addition would allow students and faculty borrowers to access the system conveniently through mobile devices, improving user experience and accessibility. Additionally, implementing a two-way authentication mechanism for student and faculty borrowers is advised to strengthen account security and ensure the integrity of all transactions.

These enhancements aim to build on the system's current functionalities, ensuring it remains efficient, secure, and accessible for all users.

Acknowledgments

I am deeply thankful to Julianito A. Batoy, Secondary Principal II of Norala National High School, for granting his approval to conduct the system testing at the school and for his support throughout the process. My heartfelt thanks also go to Kayce Mae E. Pineda, LPT, the Science Laboratory Administrator of Norala National High School, for her invaluable assistance during the system testing phase. Lastly, I to April John F. Llorito for his assistance and support during my time in Norala.

References

1. S. R. Opie, Cannabis laboratory fundamentals. 2021. doi: 10.1007/978-3-030-62716-4.
2. J. McDonald, "Revolutionizing Operational Efficiency with an Effective LIMS Implementation: A Deep-Dive into a Global Manufacturer's Journey," Thermo Fisher Scientific Inc. [Online]. Available: https://www.thermofisher.com/blog/connectedlab/revolutionizing-operational-efficiency-with-an-effective-lims-implementation-a-deep-dive-into-a-global-manufacturers-journey/
3. C. Consulting, "2023 Laboratory Trends: Data Analytics Consulting," Walk West, 2024, [Online]. Available: https://www.clarkstonconsulting.com
4. ELabNext, "Ultimate guide for lab data management," 2023, ELabNext. [Online]. Available: https://www.elabnext.com/
5. Z. Baker, S., & Bzhalava, "The role of data analytics in laboratory management- A focus on small and medium-sized laboratories," J. Lab. Autom. 26(2), pp. 103–112, 2021, doi: 10.1177/2211068219892727.
6. V. Sai and V. Siva, "Laboratory inventory management system," no. April, 2021.
7. Jayant Rajpurohit, "Laboratory information management systems (LIMS) market growth and trends 2024-2031," Mark. Res. Priv. Ltd., 2024, [Online]. Available: https://www.marketsandmarkets.com/
8. LabLynx, "Leverage Dashboards & Data Visualization in LIMS for Smarter Labs," LabLynx, Inc., 2024, [Online]. Available: https://www.lablynx.com/resources/articles/leveraging-dashboards-and-data-visualization-in-lims-for-smarter-lab-decisions/
9. G. Singh, "Lab Informations Management System," Scispot, 202AD, [Online]. Available: https://www.scispot.com/lims
10. C. T. Gonçalves, M. J. A. Gonçalves, and M. I. Campante, "Developing Integrated Performance Dashboards Visualisations Using Power BI as a Platform," Inf., vol. 14, no. 11, 2023, doi: 10.3390/info14110614.
11. B. A. Wilbanks and P. A. Langford, "A review of dashboards for data analytics in nursing," CIN - Comput. Informatics Nurs., vol. 32, no. 11, pp. 545–549, 2014, doi: 10.1097/CIN.0000000000000106.
12. Kyle McDuffie, "Data visualization of lab informatics to improve ROI," CSols Inc., 2024, [Online]. Available: https://www.csolsinc.com/about-us/case-studies/