BARCODE LIBRATRACK WITH DATA ANALYTICS

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Keywords
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Abstract

The Barcode LibraTrack with Data Analytics is a web-based system developed to automate library attendance tracking and enhance data-driven decision-making at Iloilo Science and Technology University Miagao Campus (ISAT U MC). The study was initiated in response to the inefficiencies of manual logging, which hindered accurate record-keeping and statistical reporting in the campus library. By integrating barcode scanning technology with a centralized database, the system enables students and faculty to log their attendance through their library cards with barcode, ensuring quick and accurate entry processes and minimizing errors. The system features a dashboard that visualizes library usage demographics through word cloud, bar chart, doughnut chart, pie chart, line chart, and polar area chart, allowing librarians to monitor engagement, identify trends, and allocate resources effectively. Additionally, the system incorporates data analytics to interpret visual data and provide descriptive analysis. Developed using HTML, CSS, PHP, and MySQL, the system followed the Iterative Software Development Methodology to ensure continuous refinement based on user feedback. Evaluation based on ISO/IEC 25010:2023 software quality model confirmed the system's compliance with the standard. In conclusion, the Barcode LibraTrack with Data Analytics successfully addressed the limitations of manual attendance tracking, improved operational efficiency, and empowered library personnel with actionable insights for service enhancement.

1. Introduction

Barcode-based library management systems have revolutionized the way libraries operate, offering efficient solutions for tracking resources and managing attendance. These systems leverage barcode technology to streamline operations, reduce manual errors, and provide timely data for informed decision-making. The library at the Iloilo Science and Technology University Miagao Campus (ISAT U MC), serving a significant student population across various departments, currently relies on manual methods for tracking student and faculty attendance. This approach, while traditional, presents several challenges in terms of efficiency and accuracy. Recognizing the potential for improvement, this study explores the integration of barcode technology in the ISAT U MC library management system, with a particular focus on automating attendance management and incorporating data analytics to enhance library services.

However, the researchers found a gap in the previous study, the absence of data analytics integration to provide visual representations such as word cloud, bar chart, doughnut chart, pie chart, line chart, and polar area chart, for improved data interpretation. While the previous study focused on automating attendance tracking and inventory management using RFID, it lacked functionalities that assist librarians in deeper analysis, strategic decision-making, record archiving, evaluation, and comprehensive statistical reporting. Moreover, RFID implementation, while efficient, requires higher investment in hardware and infrastructure, making it less feasible for institutions with limited budgets. Barcode technology, on the other hand, offers a more economical solution while still providing reliable automation for attendance tracking and system integration.

With the aim to improve and address the problem in the library, the researchers were motivated to develop a barcode-based library system that tracks student and faculty attendance, utilize data analytics for enhanced data interpretation, and generate statistical reports. The system reduces manual work and attendance inaccuracies by automating the logging process. Moreover, it supports decision-making by leveraging data analytics to uncover usage patterns, monitor engagement, and prescribe actions in library utilization.

Objectives of the Study

The main objective of this study was to develop Barcode LibraTrack with Data Analytics.

Specifically, this study aimed to:

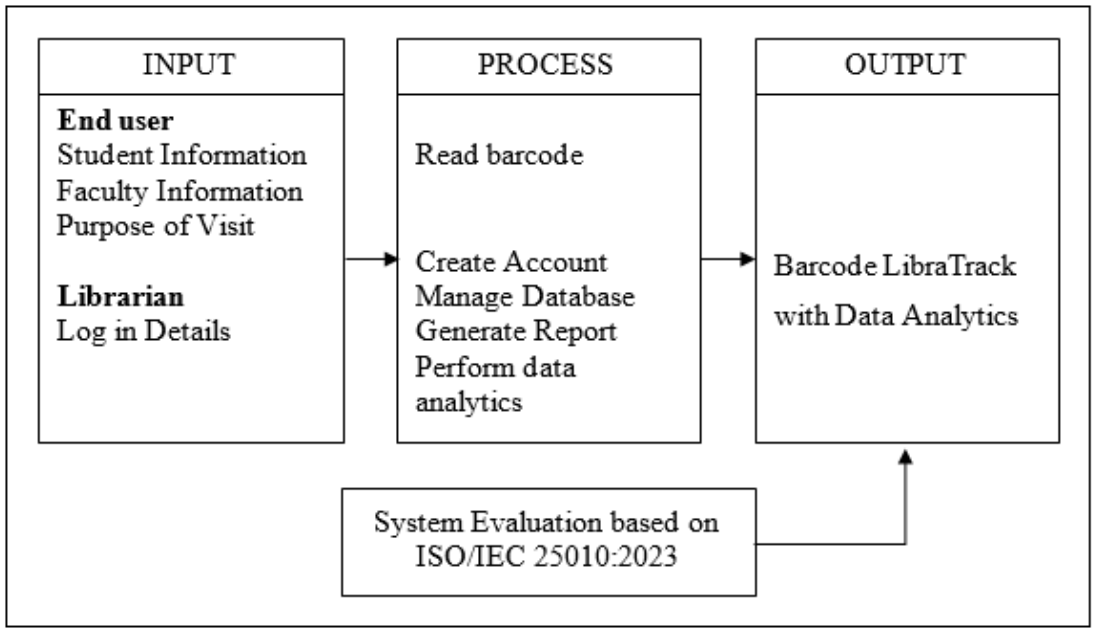
a. create database to store student and faculty information;
b. record and manage attendance using barcode technology;
c. develop interface for library usage demographics;
d. analyze and interpret library usage demographics;
e. generate report; and

f. evaluate the system based on ISO/IEC 25010:2023.

1.1 Conceptual Framework

Figure 1 illustrates the conceptual framework of the study.

Figure 1. *Conceptual Framework of the Study*



In the input, the data source originated from the end-user library card, which contained a barcode linked to end users information stored in the database. For students, the data included student ID, first name, middle initial, last name, sex, course, year level, and validation status. For faculty, the data included faculty ID, first name, middle initial, last name, sex, and active status. When the barcode was scanned, the system retrieved the corresponding information from the database and displayed it on the interface. The end user then selected a purpose of visit, choosing from predefined options such as study, borrow book, research, and "Others" to specify the purpose of visit. The selected purpose of visit was stored in the database as part of the attendance record. Additionally, librarians logged into the system using their account details to access and manage system functionalities.

In the process, the system read the barcode and verified the information retrieved from the database. For librarians, system access was validated through password-based login authentication. Once logged in, librarians performed several functions, including creating and managing library staff accounts, maintaining the database, generating reports,

and conducting data analysis. These processes ensured that end users attendance and records were properly managed and updated.

The output of the study was a functional system entitled "Barcode LibraTrack with Data Analytics". The system outputs were classified into two main categories. First, for end users, the outputs included the display of personal information, the purpose of visit, and attendance records. Second, for librarians, the system provided an interface that enabled access to managed end user records, generated statistical reports, and displayed demographic charts. The demographic charts, such as word cloud, bar chart, doughnut chart, pie chart, line chart, and polar area chart, support the analysis and monitoring of library usage trends, patterns, and comparisons. Additionally, the system incorporates data analytics to interpret visual data and provide descriptive analysis.

Finally, the system underwent evaluation based on ISO/IEC 25010:2023, known as Systems and Software Quality Requirements and Evaluation (SQuaRE), to ensure compliance with quality standards and to provide a basis for feedback and further system improvement.

1.1 Literature Review

This chapter explores the theoretical and technical foundations of technologies that underpin the Barcode LibraTrack with Data Analytics, a library management system to track student and faculty attendance. By reviewing existing literature in the fields of barcode technology, data analytics, library attendance, demographic chart, and statistical reporting, this chapter highlights the trends, challenges, and opportunities associated with integrating these technologies in library settings.

Barcode Technology

Barcode technology uses optical scanners to read data such as numbers, letters, images, and locations Elaskari et.al (2021). To process information efficiently, the computer reads the patterns of ones and zeros encoded in the bars and spaces as either numeric or alphabetic data when the image is scanned (Dickson, 2023).

A study by Hakim et al. (2023), entitled "Empowering Library Attendance System with IoT-Enabled Student ID Cards," introduced an IoT-based library attendance system that highlights the features of barcode-enabled student ID cards, Raspberry Pi 3 hardware, and integrated front-end and back-end software. These features collectively automate the process of recording visits through barcode scanning, thereby reducing the workload of librarians while ensuring efficient attendance management. In addition, the system incorporates advanced features such as real-time data collection, user information management, visit report generation, and enhanced security. By embedding IoT capabilities into barcode technology, the

system not only simplifies check-ins but also generates meaningful insights, optimizes resource utilization, and strengthens library security, ultimately enhancing the overall effectiveness of attendance monitoring in academic institutions.

2. Methodology

This study utilized the Iterative methodology allows developers to begin the development process without requiring a complete product specification. In this approach, a specific portion of the software is designed and coded first, after which the specifications are revisited to guide the development of the succeeding components. This process enables continuous refinement and progressive completion of the system (Vardomatski, 2024).

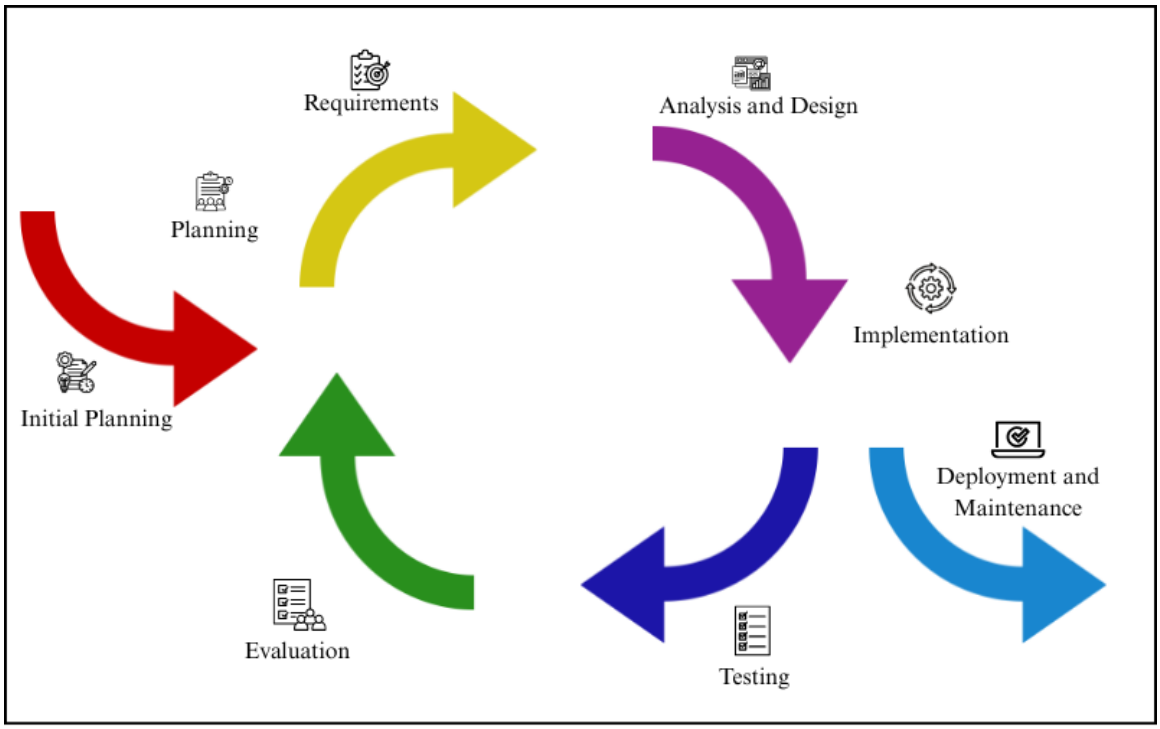


Figure 2. *Iterative Methodology (Vardomatski, 2024)*

Initial planning

In this phase, the researchers observed that manually recorded attendance in the library was time-consuming and led to inefficiencies. Some end users forgot or chose not to write their information, while others provided incomplete details, resulting in errors and inconsistencies in attendance tracking also confirmed by the librarian and library staff. From these observations, the researchers developed a plan to automate library attendance by using the existing library cards with barcodes. The basic requirements and goals of the system were identified, and the scope, limitations, and background of the current manual process were also discussed and documented.

Planning

In this phase, the researchers interviewed the head librarian, Dr. Sherryl N. Buño, and gained a clearer understanding of the importance of keeping the library attendance records. The interview showed that tracking attendance was important for creating reports on library room usage. This could help in evaluating how the library was utilized and on the management of resources. Dr. Buño also explained the problems in manual recording of attendance and preparing for reports, and which needs for a more accurate and efficient system. From these findings, the researchers listed the needed inputs, processes, and outputs of the system. The activities in this phase included the gathering of end user requirements, planning how barcodes would be used to automate attendance logging, and working with library staff ensured the system design and solved the main problems of the manual process.

Requirements

In this phase, the researchers identified the main requirements of the system. This included barcode scanning for both student and faculty IDs, automated recording of attendance, and the generation of reports for evaluation purposes. The target end users of the system were students, and faculty members. The librarian and library staff are the people who would manage the system.

Analysis and Design

In this phase, the researchers made diagrams for the system design, including the structure of the database and the layout of the end user's interface. A programming language was chosen to turn the design into working code, and each part of the system was created and tested based on how different end users would use it. Several options for connecting barcode scanners were studied, and the most effective method was selected. Problems that appeared during development were solved with practical solutions, and plans for future improvements were also made. Feedback from the client was reviewed and added to the system to make sure it continued to improve and work better.

Implementation

In this phase, the programmer coded the basic functionalities of the system and developed features such as automated attendance record, library card validation, report generation, and data analytics. The researchers utilized the MySQL database server and created a table to store the data needed for the system. The programing languages used are Hypertext Preprocessor (PHP) and JavaScript for the development of the entire system as well as for querying. The system designer

created the design and proceeded to the actual interface of the entire system using Cascading Style Sheets (CSS).

Testing

In this phase, the researchers tested the system and ensured that it has met the client's needs and specifications. The functions for barcode scanning, report generation, and student and faculty ID processing were checked for accuracy in design. Each feature was tested during the coding process, and any error found in the system was corrected. Every modification was verified using test cases to confirm that the functions worked as intended. Finally, a live mock test was conducted inside the library to check the accuracy of the system and to ensure that the barcode scanner was functioning properly. Students who entered the library were invited to test the system to assess their satisfaction and provide feedback for further refinements. It was found that when the barcode printed on the library card is exposed to moisture or smudged, the scanner has difficulty reading it.

Evaluation

In this phase, the researchers ensured that the system has met the objectives and the end users' requirements. Testing results were assessed through the collection of user feedback, examination of the system functions, and identification of areas that requiring improvement. The system was evaluated based on ISO/IEC 25010:2023 software quality standards. A total of ten (10) IT specialists, fifteen (15) end users, three (3) librarians, and two (2) library staff members participated in the evaluation. The participants were asked to rate the performance of the system using a Likert scale, which allowed the researchers to measure the system's quality based on user experience.

Deployment and Maintenance

In this phase, the researchers enhanced the Barcode LibraTrack with Data Analytics by incorporating the changes suggested by end users. New options were developed, and the user interface was refined to make the system easier to use. The existing code was also optimized to ensure smooth operation, and testing was conducted to address any issues that appeared.

3. Result and Discussion

A. Create Database to Store Student and Faculty Information.

The first objective of the system is to establish a database that securely stores all relevant student and faculty information. The student table is designed to hold

essential fields such as student ID, first name, middle initial, last name, sex, course, year level, and validation status.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	student_id	varchar(11)	latin1_swedish_ci		No	None			Change Drop More
2	first_name	varchar(50)	latin1_swedish_ci		No	None			Change Drop More
3	middle_initial	varchar(2)	latin1_swedish_ci		No	None			Change Drop More
4	last_name	varchar(50)	latin1_swedish_ci		No	None			Change Drop More
5	sex	varchar(6)	latin1_swedish_ci		No	None			Change Drop More
6	course	varchar(150)	latin1_swedish_ci		No	None			Change Drop More
7	year_level	varchar(10)	latin1_swedish_ci		No	None			Change Drop More
8	validation_status	varchar(13)	latin1_swedish_ci		No	None			Change Drop More

Figure 3. *Database Structure to Store Student Information*

The student table functions as an organized storage for student information. Each student is assigned a unique student_id to ensure that duplicate entries are avoided. It records essential personal details such as first_name, middle_initial, last_name, and sex for accurate identification. Academic information is also included, with the course field classifying students based on their chosen program of study. The year_level field indicates the student's current standing, such as first year, second year, and so forth. Finally, the validation_status field determines whether a student's ID is authorized for library access.

Figure 4. *Database Structure to Store Faculty Information*

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	faculty_id	varchar(11)	utf8mb4_general_ci		No	None			Change Drop More
2	first_name	varchar(50)	utf8mb4_general_ci		No	None			Change Drop More
3	middle_initial	varchar(2)	utf8mb4_general_ci		No	None			Change Drop More
4	last_name	varchar(50)	utf8mb4_general_ci		No	None			Change Drop More
5	sex	varchar(6)	utf8mb4_general_ci		No	None			Change Drop More
6	active_status	varchar(10)	utf8mb4_general_ci		No	None			Change Drop More

The faculty table serves as a structured storage for faculty records. Each faculty member is assigned a unique faculty_id to avoid duplication of entries. It stores essential personal details such as first_name, middle_initial, last_name, and sex to ensure accurate identification. In addition, the active_status field specifies whether the faculty member's ID is valid for library access.

B. Record and Manage Attendance Using Barcode Technology.

The second objective of the system is to allow librarians and library staff to manage student and faculty information, including adding new student records.

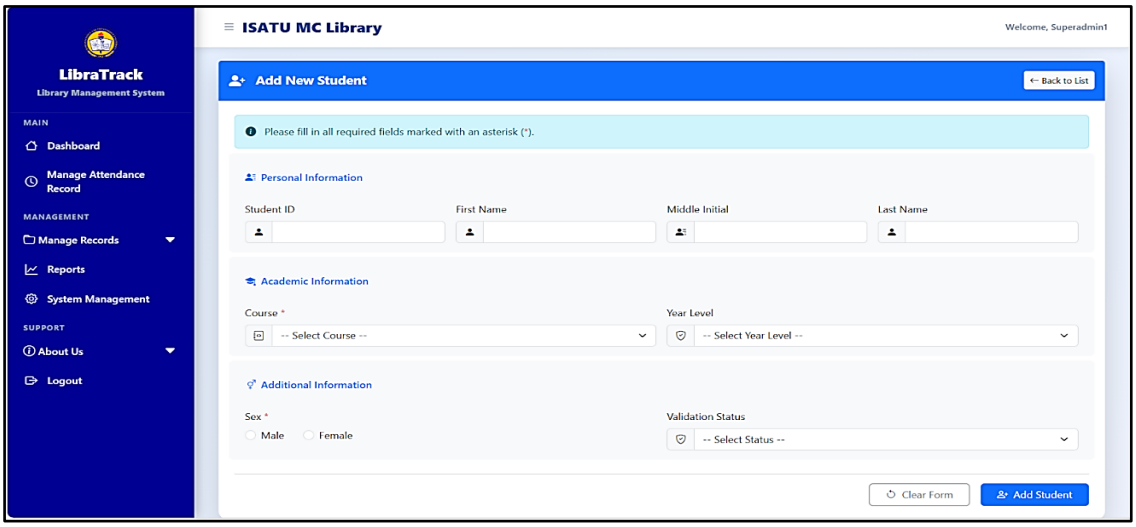


Figure 5. *Interface for Add Student Information*

To add a student, the librarians and library staff completed the required fields with the corresponding details, including student ID, first name, middle initial, last name, course, year level, sex, and validation status.

C. Develop Interface for Library Usage Demographics.

The third objective of the system is to display library usage demographics for better visualization of attendance data.

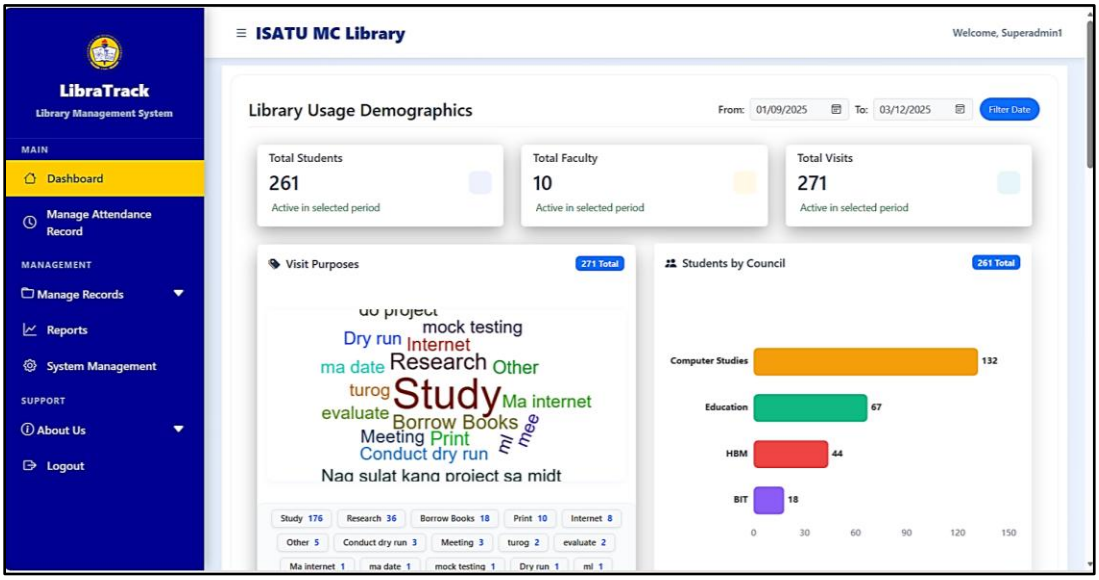


Figure 6. *Interface for Library Usage Demographics*

The library usage demographics are designed to display library attendance in filtered time periods. The graphs include both textual and graphical information. The textual data present the total number of students, faculty, and overall visits. The graphical data illustrate visit purposes, student attendance by council, faculty versus student visits, course-wise trends, visits by hour, monthly attendance, weekly attendance, sex distribution, top students users, and attendance from the previous month. This information helps librarians make informed decisions and allocate resources properly.

D. Analyze and Interpret Library Usage Demographics

The fourth objective of the system is to enable librarians to analyze and interpret information for both students and faculty.

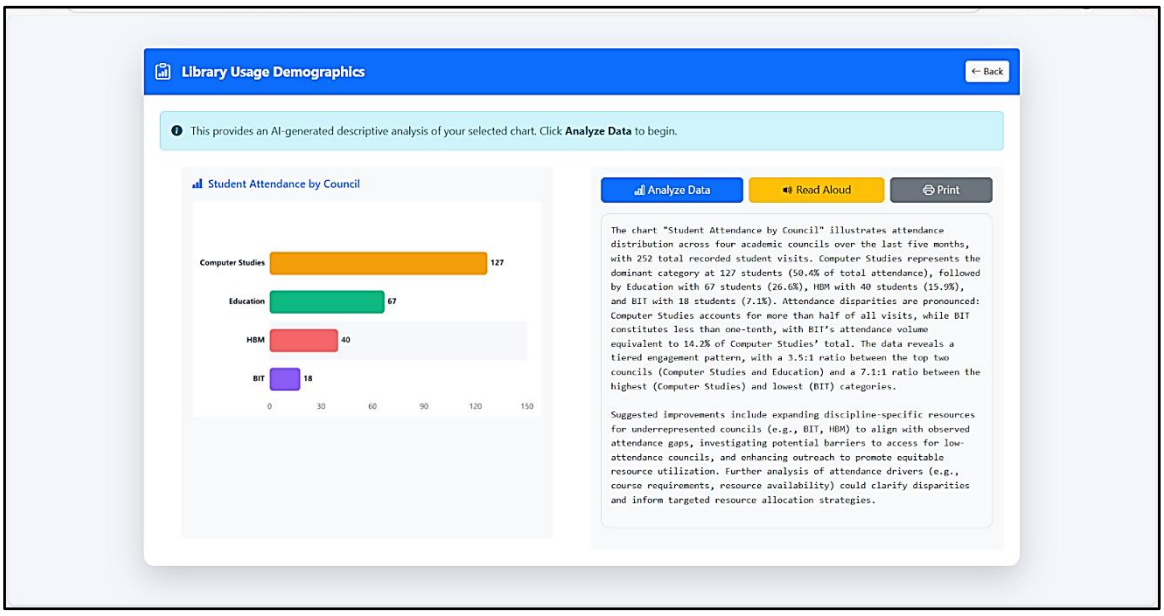


Figure 6. *Analyze and Interpret Library Usage Demographics*

The system illustrates data analytics feature, which enables automated interpretation of attendance data through graphical representations. Upon clicking the Analyze Data button, the system processes the selected chart and generates a corresponding textual interpretation. To enhance accessibility, the Read Aloud button activates a text-to-speech function that vocalizes the system-generated insights. Additionally, the Print button allows librarians to produce hard copies of the chart along with its interpretation for reporting or archival purposes.

E. Generate report

The fifth objective of the system is to generate reports.

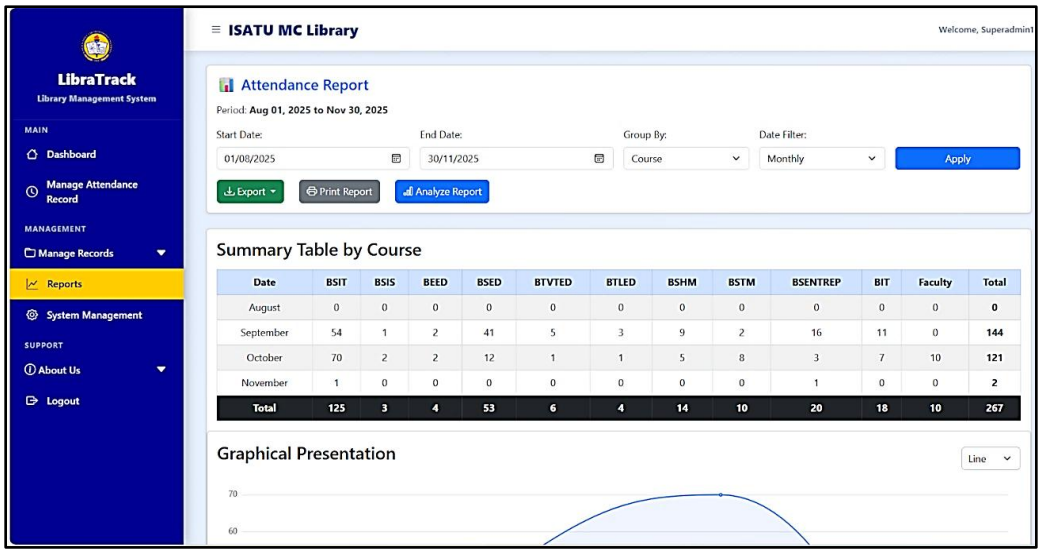


Figure 7. *Generate Report*

Figure 7 shows a report feature that allows the administrator to select the start and end dates to define the coverage period. Reports may be grouped by course, council, or sex to provide a clearer view of library usage patterns across categories. The date range can also be filtered by day, month, or year to highlight trends within a specific time frame. Once generated, report is exported as CSV and Word Document for further processing and printed for official use. The administrator also chooses the preferred type of graphical presentation, such as line, bar, pie, doughnut, or polar area charts. These options provide flexibility in presenting data, making it easier to interpret results, identify patterns, and support data-driven decision-making.

F. Evaluate the system based on ISO/IEC 25010:2023

The ISO/IEC 25010:2023 criteria for software evaluation were adopted to evaluate the system. Ten (10) IT Experts and Twenty (20) end users from the library were identified to evaluate the system using Likert Scale Rating shown below:

Table 1

Result of Evaluation of IT Experts based on ISO/IEC 25010:2023

Characteristics	Mean	Description
Functional Suitability	4.77	Excellent
Performance Efficiency	4.87	Excellent
Compatibility	4.40	Very Satisfactory
Interaction Capability	4.66	Excellent
Reliability	4.58	Excellent
Security	4.70	Excellent
Maintainability	4.44	Very Satisfactory
Flexibility	4.68	Excellent
Safety	4.34	Very Satisfactory
Overall Result	**4.60**	**Excellent**

Note: *4.50 – 5.00 Excellent; 3.50 – 4.49 Very Good; 2.50 – 3.49 Good; 1.50 – 2.49 Fair; 1.00 – 1.49 Poor*

Table 1 presents the evaluation results of the system conducted by ten (10) IT experts. The assessment was based on nine criteria, namely functional suitability, performance efficiency, compatibility, interaction capability, reliability, security, maintainability, flexibility, and safety. The obtained mean scores were as follows: functional suitability (M = 4.77), performance efficiency (M = 4.87), compatibility (M = 4.40), interaction capability (M = 4.66), reliability (M = 4.58), security (M = 4.70), maintainability (M = 4.44), flexibility (M = 4.68), and safety (M = 4.34). The findings indicate that the system satisfied the ISO/IEC 25010:2023 standards and received an overall descriptive rating of "Excellent" from the IT experts. These results imply that the developed system possesses high-quality software attributes and performs effectively in meeting user requirements.

Table 2

Result of Evaluation of End Users based on ISO/IEC 25010:2023

Variables	Mean	Description
Functional Suitability	4.83	Excellent
Performance Efficiency	4.80	Excellent
Compatibility	4.70	Excellent
Interaction Capability	4.78	Excellent
Reliability	4.71	Excellent
Security	4.81	Excellent
Safety	4.83	Excellent
Overall Result	**4.78**	**Excellent**

Note: *4.50 – 5.00 Excellent; 3.50 – 4.49 Very Good; 2.50 – 3.49 Good; 1.50 – 2.49 Fair; 1.00 – 1.49 Poor*

Table 2 presents the evaluation results of the system conducted by twenty (20) end users. The assessment was based on seven criteria, namely functional suitability, performance efficiency, compatibility, interaction capability, reliability, security, and safety. As shown in Table 5, the overall evaluation received an "Excellent" rating with an average mean score of (M = 4.78). The mean scores for each criterion were as follows: functional suitability (M = 4.83), performance efficiency (M = 4.80), compatibility (M = 4.70), interaction capability (M = 4.78), reliability (M = 4.71), security (M = 4.81), and safety (M = 4.83). The results indicate that the system met the ISO/IEC 25010:2023 standards and obtained an "Excellent" rating from the respondents. These findings imply that the developed system demonstrates high-quality software performance and effectively supports the intended user objectives.

4. Conclusion

Based on the findings, the development of the Barcode LibraTrack with Data Analytics successfully achieved the objectives set by the researchers. The system established a database that stores student and faculty information, ensuring organized record management and easy retrieval of data. It effectively automated the recording and monitoring of attendance through barcode technology, which replaced the manual logging process and reduced errors and delays.

An interface for viewing and interpreting library usage demographics was successfully developed. This interface presents attendance data through visual charts and graphs, such as bar, pie, line, doughnut, and polar area charts, which help librarians understand patterns of library use. The integration of data analytics allowed the system to generate descriptive insights that support evaluation, planning, and decision-making.

Moreover, the system can generate statistical reports that summarize attendance records and usage trends. These reports assist librarians and administrators in evaluating library operations and improving services. The system was also evaluated based on ISO/IEC 25010:2023 software quality standards by IT experts and end users. The results showed that the system met the standards for functionality, reliability, compatibility, performance, and security, and it received an overall rating of "Excellent".

In conclusion, the Barcode LibraTrack with Data Analytics proved to be a reliable and efficient solution for automating library attendance, visualizing usage data, and providing accurate and data-driven reports. It addressed the limitations of the manual process and offered a modern, user-friendly system that enhances library management and decision-making at ISATU MC.

5. References

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