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RESEARCH ARTICLE

Development of a Computer-Based Laboratory Equipment Record System at SMA Negeri 1 Mutiara, Pidei Regency

Nurbayani [1*]

[1] Informatics Management Study Program, STMIK Indonesia Banda Aceh, Banda Aceh City, Aceh Province, Indonesia.

Correspondence

[1*] Informatics Management Study Program, STMIK Indonesia Banda Aceh, Banda Aceh City, Aceh Province, Indonesia.
Email: nurbayani@gmail.com

Funding information
STMIK Indonesia Banda Aceh.

Abstract

The advancement of information technology has significantly impacted various sectors, including education. One of the critical areas in education is the management of laboratory equipment, which traditionally relies on manual systems. This study focuses on the development of a computer-based information system for managing laboratory equipment at SMA Negeri 1 Mutiara, Pidei Regency. The existing manual system was found to be inefficient, leading to frequent errors, delays in maintenance, and difficulties in tracking equipment. The primary goal of this research is to design and implement a system that can automate the recording, categorization, and reporting of laboratory equipment, thus improving the efficiency and accuracy of the process. By utilizing tools such as Microsoft Access and Visual Basic, the proposed system integrates data management processes, providing a more streamlined and error-free system for equipment management. The research follows a structured approach, starting with system analysis, followed by database design, system development, testing, and implementation. The system is designed to be user-friendly, allowing school staff to manage equipment data efficiently, generate timely reports, and ensure proper maintenance. The implementation of this system is expected to reduce errors, speed up data entry, and facilitate better decision-making regarding equipment procurement and maintenance. This study aims to demonstrate the potential of computer-based systems in improving the management of educational resources, ultimately contributing to a more efficient and effective learning environment.

Keywords
Laboratory Equipment Management; Information System; Computer-Based System; Microsoft Access; Visual Basic.

1 | INTRODUCTION

The advancement of information technology has significantly impacted almost all aspects of human life, including the education sector. The utilization of technology in education is not limited to teaching and learning but extends to data management, such as the recording and management of laboratory equipment. In many schools, particularly at SMA Negeri 1 Mutiara in Pidei Regency, the recording and maintenance of laboratory equipment are often done manually. This method not only consumes a lot of time but also has the potential to introduce errors in the records, which can disrupt the smooth flow of the learning process. The management of laboratory equipment in schools often relies on conventional approaches, causing difficulties in accessing data and tracking the status of equipment, which negatively affects teaching and learning activities. The current manual system is ineffective in addressing modern challenges, such as frequent equipment breakdowns or unavailability when needed. This results in delays in equipment maintenance and a decline in the quality of education in the laboratory (Susanto *et al*., 2021).

The implementation of a computer-based information system is expected to improve this situation. With an integrated system, all data related to laboratory equipment can be recorded, accessed, and managed efficiently. Research has shown that a good information system can help reduce the potential errors often encountered in manual systems while improving the speed and accuracy of recording and maintaining equipment (Sanjaya *et al*., 2022). Studies conducted in information technology laboratories show that web-based systems are highly effective in improving management, especially in areas such as equipment borrowing and return processes (Arisandi *et al*., 2023). The aim of this research is to design a computer-based information system that supports the management of laboratory equipment at SMA Negeri 1 Mutiara. By adopting software such as Microsoft Access and Visual Basic, it is hoped that this system will replace the outdated manual method and provide convenience for the administrators. With this system in place, the school can more easily monitor equipment usage, speed up the borrowing process, and generate more accurate and timely reports, which are crucial for the success of the teaching and learning activities (Assagaf *et al*., 2018).

The system development process begins with an analysis of the existing system, followed by the design of the database and user interface. It is important that the resulting system development is not solely focused on technology but also aligns with the real needs of the users in the field (Wati *et al*., 2023). A more organized management system is expected to significantly contribute to the improvement of the quality of laboratory learning, thus creating a better learning environment in the future (Laning *et al*., 2024). Through the development of this system, SMA Negeri 1 Mutiara is expected to increase the efficiency of laboratory equipment management, improve equipment maintenance processes, and provide more accurate data for decision-making regarding the procurement of new laboratory equipment. This system will not only enhance the laboratory's performance but will also provide long-term benefits for the overall school inventory management.

With this integrated information system, it is anticipated that SMA Negeri 1 Mutiara will be able to optimize the use of laboratory equipment, reduce the likelihood of errors in data recording, and ensure that reports are generated quickly and accurately. Furthermore, the availability of accurate and timely data will play a critical role in the school's decision-making process, particularly in the planning for future equipment purchases and maintenance. By implementing a well-organized and efficient information system, the school can improve the management of resources, ensuring that the laboratory operates at full capacity and is always ready to support students' practical learning experiences. Ultimately, this system is expected to enhance the overall learning environment and contribute to the long-term success of the educational institution.

2 | BACKGROUND THEORY

Information systems play a crucial role in improving the effectiveness of laboratory management in schools, including at SMA Negeri 1 Mutiara, where manual recording of laboratory equipment often leads to errors and inaccuracies in data. These errors can directly affect the learning process, as incorrect data can hinder the tracking and maintenance of laboratory equipment. Several studies indicate that implementing computer-based information systems can address these issues. For example, the implementation of a web-based laboratory management information system has proven to be essential in improving data accuracy and operational efficiency in laboratories (Wibowo *et al*., 2021). Improving laboratory management requires technology that facilitates the design of efficient systems. The use of software such as Microsoft Access and Visual Basic has been shown to provide ease in designing simple and intuitive user interfaces. This enables users, who may not have technical expertise, to efficiently record and report data accurately (Nurjali *et al*., 2023). This aligns with research stating that QR Code-based systems can optimize laboratory equipment inventory by facilitating the description and tracking of equipment more effectively (Jaya *et al*., 2023). By using QR Code technology, each laboratory tool can be assigned a unique code, making it easier to manage data and track equipment

status quickly and accurately.

One key aspect of developing a good information system is database normalization. Database normalization is a technique used to reduce data redundancy and improve the consistency of data stored in the database. Research into the management of laboratory tools and materials indicates that a structured approach, including the application of data normalization, can minimize data duplication, which may lead to inconsistencies. Consistent data management is essential for designing systems that are not only efficient but also reliable. Laboratory managers require systems that not only store data properly but also facilitate data search and processing for laboratory equipment (Pratiwi *et al*., 2023). In addition to normalization, system analysis is also an important phase in developing an information system. System analysis aims to understand the needs and problems within the existing system. Studies in various laboratories show that a thorough analysis of existing procedures can lead to system designs that are more aligned with user needs. In the context of educational laboratories, this analysis process is critical to ensure that the designed system meets the requirements for managing laboratory tools effectively and efficiently. Proper analysis also ensures that the system developed will function optimally as expected (Sweden *et al*., 2022). Therefore, involving stakeholders in the analysis phase is crucial to ensure that the developed system is relevant to their needs and operates optimally.

The implementation of the information system at SMA Negeri 1 Mutiara aims to replace the outdated manual recording methods and enhance the efficiency of laboratory equipment management. With a computerized system, it is expected that errors in data recording will decrease, the speed of data processing will improve, and the monitoring of equipment will become faster and more effective. With this new system, the maintenance process of laboratory tools will be more organized, and the reports generated will be more accurate and timely. This is essential for the success of teaching and learning activities, as properly functioning equipment supports student practical sessions and experiments. Innovations implemented in this system, as demonstrated in previous studies in various educational institutions, show positive effects on teaching and learning activities. The application of a more efficient and accurate system for managing laboratory equipment ensures that tools are always ready for use, supporting better learning activities. Thus, it is expected that laboratory management at SMA Negeri 1 Mutiara will become more efficient, which will in turn improve the quality of education in the laboratory and positively impact all academic activities at the school.

3 | METHOD

This study adopts a Research and Development (R&D) approach, focusing on the development of a computer-based information system for managing laboratory equipment at SMA Negeri 1 Mutiara. This approach aims to create a system that can be directly implemented in the school environment and provide a practical solution to the issues faced in the management of laboratory equipment. The research process consists of several stages, beginning with the needs analysis, system design, system development, and ending with evaluation and post-implementation. The first stage is the Feasibility Study, which aims to assess whether the new system can address the issues of the existing manual system. During this stage, interviews are conducted with relevant parties such as laboratory managers, school principals, and administrative staff to understand the challenges faced with the current manual equipment recording system. This feasibility study also considers the technical factors, costs, and time required to develop the new computer-based system. The results of the feasibility study serve as the basis for proceeding with the development of the information system.

After the feasibility study, the next stage is System Design. In this stage, detailed planning is done for the database structure and user interface. Database design focuses on organizing data about laboratory equipment, categories of equipment, and processes related to borrowing and returning tools. Normalization is applied to the database to avoid data redundancy and ensure that the stored information remains consistent. For user interface design, the main focus is on creating a simple, intuitive layout that can be easily used by school personnel, including laboratory managers and administrative staff who may not have strong technical backgrounds. Microsoft Access is used to build the database, while Visual Basic is employed to develop the user interface. The next stage is System Development, where the system is built based on the design specifications. The system is developed using Microsoft Visual Basic 6.0 for the desktop application and Microsoft Access for database management. This stage includes creating various forms for data input, such as login forms, equipment data input forms, equipment category forms, and report forms. Once the application is completed, initial testing is conducted to ensure that each component of the system functions as expected.

After system development, the next stage is System Testing. This testing phase evaluates the performance of the system and ensures that the developed system works properly in real-world conditions. Users, including laboratory managers and administrative staff, are involved in testing the system. They perform tasks such as entering equipment data, borrowing equipment, and generating reports. The feedback from this testing is used to identify potential issues or deficiencies in the system that need to be addressed. Following testing and system improvements, the next phase is System Implementation. This phase involves replacing the existing manual system with the new computer-based system

at SMA Negeri 1 Mutiara. During this phase, users are trained to understand how to operate the new system to ensure smooth and efficient usage. After the system is implemented, System Evaluation is carried out to assess the extent to which the system improves the efficiency of equipment management. Evaluation involves gathering feedback from users through interviews and questionnaires, focusing on user satisfaction, ease of use, and the system's impact on the equipment management process.

Data analysis is conducted to evaluate the effectiveness of the system based on predefined parameters, such as processing speed, accuracy in equipment logging, and improvements in report generation. The data collected during testing and evaluation is analyzed using both quantitative and qualitative methods. Quantitative analysis is used to assess the time required for equipment borrowing and recording processes, while qualitative analysis is used to understand users' experiences and perceptions of the system. By following these steps, this study aims to develop an information system that not only functions effectively but also provides convenience for the school in managing laboratory equipment more efficiently. Additionally, the system is expected to enhance the accuracy of records, reduce manual errors, and expedite the process of generating reports, which previously took longer.

4 | RESULTS AND DISCUSSION

4.1 Reults

4.1.1 System Development

System development is the process of changing, replacing, or reorganizing an existing system into a new one, either partially or entirely, with the goal of improving the current system. In a dynamic organization, system development is an essential action to take, as its purpose is to enhance the mechanisms or workflows within the organization, ensuring that all aspects are better integrated into a single system or set of regulations. The main focus of development is how to transition from an old, conventional system to a more modern, computer-integrated system that facilitates data processing and produces high-quality information. This information is crucial for decision-making at the managerial level of an organization. After collecting data and documenting facts, the system analysis determines what the existing system is actually doing. Subsequently, the system analyst conducts a feasibility study to assess whether the organization or institution where the system is being created can proceed to the next phase of system development. The feasibility study serves as an initial review of the key factors that will influence the system's ability to achieve its desired goals. The initial step in system analysis is the preliminary study, which includes an understanding of the type, scope, and initial concept of the information technology system project. This preliminary study produces an early version of the system, including estimates of the costs involved and the time required for development. In the diagram below, the context of the proposed system can be clearly seen. The diagram illustrates that the recording of laboratory equipment generates data, which is then reviewed and approved by the school principal as part of the evaluation process of the equipment's recording system.

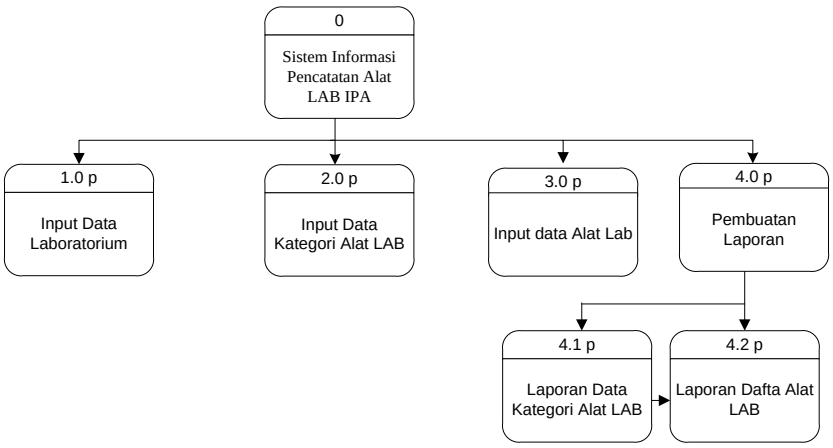

Figure 1. Hierarchical Diagram

In the process of recording laboratory equipment, there are four main stages involved. These stages are the input of laboratory data, the categorization of laboratory equipment, the recording of the equipment, and finally, the generation of reports. The transition from one process to another is clearly illustrated in the data flow diagrams. The recording process includes both the laboratory and equipment categories, which will be recorded

in the system. The final step in this process is the creation of a report, which is then submitted to the school principal for approval. The data flow diagram at level 1 further elaborates on the process of creating tables from the data that has already been collected. It shows that each data archive feeds data into its respective input process. For instance, the laboratory equipment data is provided to the equipment recording input process. After each data input process, the data will be stored in specific data files. The structure of the information system for recording laboratory equipment consists of several essential components, including login functionality, main menu, file menu, report menu, and exit menu. The implementation phase of the system is critical for making the system operational. This stage involves replacing or abandoning the old system in favor of the new one. Successfully transitioning from the old system to the new system requires a well-planned approach or strategy. It is important that the implementation process includes thorough testing and proper execution to ensure that the new system effectively meets user needs and addresses the limitations of the previous system. Proper implementation will ensure that the laboratory equipment management system becomes efficient and reliable, supporting the overall goals of the school.

4.1.2 System Design

The information system designed for SMA Negeri 1 Mutiara includes features that allow for quick and efficient data recording, ultimately enhancing the workflow within the institution. The objective of the system design is twofold: to improve the information system within the data processing procedures and to create a laboratory equipment management system using computer tools such as Microsoft Access 2007 and Microsoft Visual Basic 6.0, replacing the previously used Microsoft Excel 2007. A crucial aspect of building a reliable database is normalization, which involves organizing data into structured tables that minimize duplication and maintain consistency. The normalization process is essential for creating a relational database model where data is stored efficiently and consistently. Without normalization, data redundancy can occur, leading to inconsistencies, especially when adding or deleting information. The process starts with organizing data in a non-normalized form, where data entries are directly copied without optimization, often leading to repeating fields and attributes. In contrast, the normalized form ensures that each column and row contains only a single, atomic value, eliminating data repetition and ensuring that each data element has a unique meaning. This ensures better data management and makes it easier to process, update, and retrieve information accurately.

The system creation process follows a structured approach. First, the program folder is created by right-clicking on the "Start" menu, selecting "Explorer," choosing the "D" drive, and naming the folder "Laboratory Equipment Recording Application." Next, the project is created by opening Microsoft Visual Basic 6.0, selecting the "Standard Exe" option in the new project dialog box, and opening the project. The database is created within the system by selecting "Add_Ins" and then choosing "Visual Data Manager." A new Microsoft Access 7.0 MDB database is created, named "Data.mdb," and stored in the appropriate location. The database is structured with tables that include fields such as admin credentials, laboratory information, and equipment categories. These fields are added one by one, and the table is then built and finalized. To facilitate the creation of forms, the Login Form is designed to ensure only authorized users can access the system. When the correct username and password are entered, the main menu opens, allowing the user to access all available system functions. The form includes labels for the username and password fields, as well as buttons for login and cancellation. This approach ensures that the system is protected and that users are given the appropriate level of access to the laboratory equipment management features.

The designed system also includes a set of key features and components, such as a main menu, a file menu, a report menu, and an exit menu, which contribute to the overall functionality and usability of the system. The implementation of this system aims to replace outdated manual methods of recording laboratory equipment, improving efficiency and reducing errors in data entry and processing. By automating the management of laboratory equipment, the system will help streamline operations and ensure that equipment records are always accurate and accessible. This will not only improve day-to-day operations but also support decision-making regarding the maintenance and acquisition of new laboratory equipment.

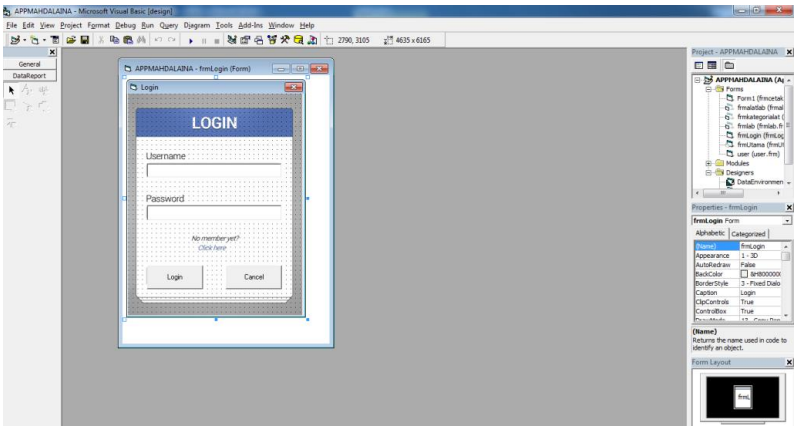

Figure 2. Login Form

The main menu form is designed to allow access to all the submenus available within the program. This form provides several menu options for users to interact with the system. It serves as the central hub from which users can navigate to various sections of the application. Key components of the main menu include a list of options and the ability to interact with different features such as reports, files, and tools. The design of the main menu ensures that users can efficiently access all functionalities without confusion. The objects and properties associated with this form include the MDIForm, which is labeled as the "Main Menu Form," along with an ImageList for icons, a Toolbar for quick access to common functions, and a StatusBar for displaying information such as the current status of the program. These elements collectively contribute to a user-friendly interface, allowing for smooth navigation within the system.

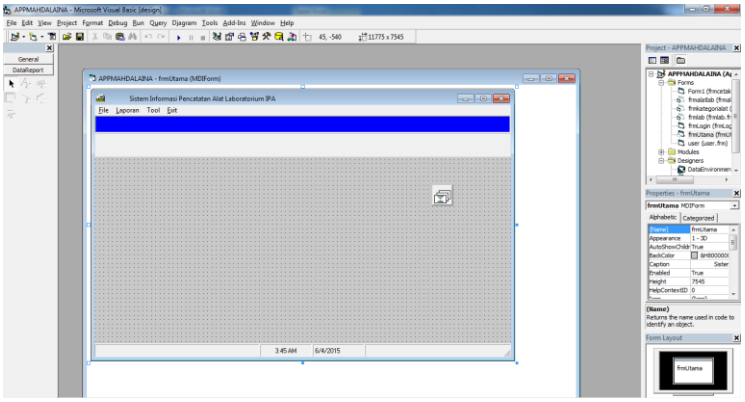

Figure 3. Main Menu Form

The User Form is created to allow the input of user data, specifically for registering system users within the laboratory equipment application. This form includes fields where the user can enter essential details like their username and password. It also contains buttons for submitting or canceling the input. The design ensures that the system is secure, allowing only authorized personnel to access it. The form features labels for "Username" and "Password" and buttons such as "OK" and "Cancel" to either confirm or cancel the data entry process. The Equipment Category Form is used for entering data about the different categories of laboratory equipment. It provides fields such as "Category Code," "Category," and "Remarks." Additionally, it includes action buttons like "Add," "Cancel," "Save," "Edit," "Delete," and "Exit," which enable users to easily manage the equipment categories. By categorizing the equipment, the system helps ensure that each item is correctly classified, simplifying the process of tracking and managing laboratory tools.

The Laboratory Form is designed for recording and managing laboratory data, as well as organizing equipment assigned to each lab. The form includes fields like "Laboratory Code," "Laboratory Name," and "Remarks." Users can add, cancel, save, edit, or delete laboratory information using the buttons provided. This design makes it easier to manage various laboratory records within the system, ensuring that data is consistently organized and accessible. The Equipment Form focuses on the input and management of laboratory equipment data. Fields like "Equipment Code," "Date Entered," "Time," "Equipment Name," "Category Code," "Laboratory Code," and "Remarks" are included for detailed entry. This form provides options for adding, updating, or removing equipment data, ensuring accuracy and ease of use. Action buttons like "Add," "Cancel," "Save," "Edit,"

"Delete," and "Exit" streamline the process, allowing users to efficiently manage laboratory equipment. The design of the laboratory equipment report output includes 12 labels, each representing a piece of important information related to the equipment. The layout ensures that all relevant data is displayed clearly and in a structured format, making it easier for users to review and manage the equipment. This approach guarantees that the report is practical and useful for personnel responsible for managing the laboratory tools.

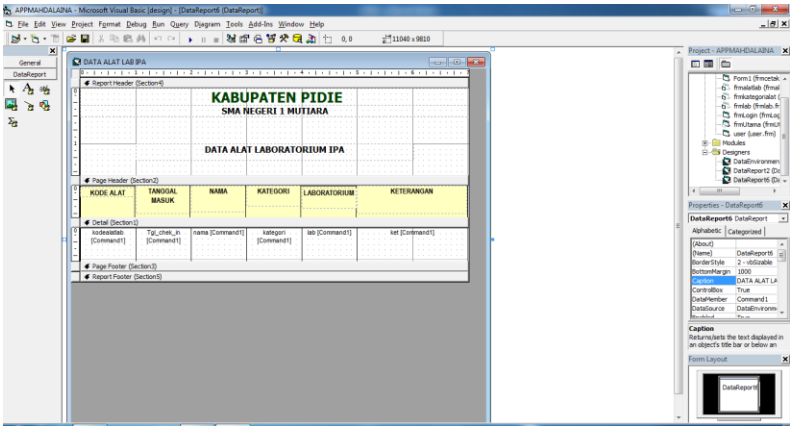

Figure 4. Laboratory Equipment Recording Data Report

This figure illustrates the design of the "Laboratory Equipment Recording Data Report" in Microsoft Visual Basic. The report layout includes a Page Header displaying the title "KABUPATEN PIDIE SMA NEGERI 1 Mutiara," indicating the school and region, along with "DATA ALAT LABORATORIUM IPA" to specify the subject. Below the header, the Page Header Section includes labeled columns for "Kode Alat," "Tanggal Masuk," "Nama," "Kategori," "Laboratorium," and "Keterangan." These columns are designed to capture and organize data such as equipment codes, entry dates, names, categories, laboratories, and remarks. The Detail Section displays dynamic data entries for each piece of laboratory equipment, corresponding to the columns mentioned. This structure ensures clear and systematic presentation of equipment details, facilitating better organization and review. The report is essential for efficiently managing and tracking laboratory equipment, ensuring all necessary information is recorded and easily accessible for school management.

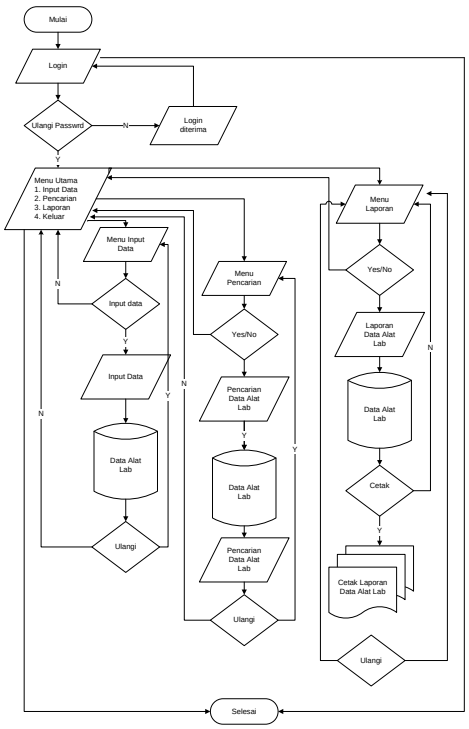

Figure 5. Flowchart

The flowchart outlines the process for managing laboratory equipment data within the system. The process begins when the user logs in by entering a username and password. If the credentials are incorrect, the system prompts for re-entry. Once successfully logged in, the user accesses the Main Menu, which offers four options: Input Data, Search, Reports, and Exit. Selecting Input Data takes the user to the Input Data Menu, where new laboratory equipment information can be entered. After the data is recorded, it is saved in the Laboratory Equipment Data section. The user can choose to return to the input menu or proceed to another task. Opting for Search leads to the Search Menu, where the user can search for specific equipment records. The results are displayed, and the user has the option to either go back to the search menu or generate a report. Choosing Reports allows the user to generate a report of laboratory equipment data. Once the report is ready, the user can print it or return to the main menu. Lastly, selecting Exit logs the user out, returning the system to the initial login screen. This process ensures smooth navigation and effective management of laboratory equipment data.

4.2 Discussion

System development is a crucial aspect of organizational growth, especially when transitioning from outdated manual processes to modern, computer-integrated systems. As emphasized by Susanto *et al*. (2021), the main objective of system development is to enhance workflows and integrate all components into a unified system, which results in better decision-making and increased efficiency. The process of replacing old, conventional systems with automated ones ensures that data processing is streamlined, providing accurate information that can aid in decision-making at the managerial level. The findings of Sanjaya *et al*. (2022) also support this, highlighting how effective system development improves data management, making it easier to maintain laboratory equipment records and manage inventories efficiently. In this research, the transition involves an initial system analysis followed by a feasibility study, as noted by Wati *et al*. (2023), which ensures that the system can meet the desired goals. The analysis helps assess how the new system will function within the existing infrastructure, providing a roadmap for the entire development process. A key component of the system design is database normalization, which is essential for organizing data into structured tables that minimize duplication and enhance consistency. This practice aligns with the approach recommended by Arisandi *et al*. (2023), who emphasized the importance of database normalization in maintaining data integrity. The implementation phase, as pointed out by Assagaf *et al*. (2018), is critical for ensuring that the new system works effectively. It involves replacing the old system with the new one and ensuring that it is fully operational. Thorough testing is crucial at this stage, ensuring that the system performs according to expectations. Testing and user training, as suggested by Wibowo *et al*. (2021), ensure smooth operation and that the system's functionalities are well-understood by the users.

The design of the system incorporates several key features, including user forms, equipment categorization, and the generation of reports. These features, as discussed by Sweden *et al*. (2022), are designed to make the system user-friendly while streamlining the process of managing laboratory equipment. The user interface is built to allow easy navigation between menus, such as input data, search functions, and report generation. The integration of these features improves both the accessibility and usability of the system, ensuring that users can efficiently manage laboratory equipment data. Finally, as emphasized by Laning *et al*. (2024), the new system is expected to enhance day-to-day operations by ensuring that laboratory equipment records are accurate and easily accessible. This will not only improve operational efficiency but also support long-term decision-making regarding the maintenance and acquisition of new laboratory equipment. The research highlights that such systems contribute to the overall goals of the institution by improving the management and usability of laboratory resources, ultimately creating a more organized and efficient environment for educational purposes. The development of a laboratory equipment management system at SMA Negeri 1 Mutiara aligns with current best practices in system design and development. By incorporating elements such as database normalization, user-friendly interfaces, and systematic implementation, the system will improve the efficiency of equipment management, reduce errors, and support better decision-making. The results of the study by Susanto *et al*. (2021), Sanjaya *et al*. (2022), and other referenced works underscore the importance of these systems in improving educational environments and ensuring that resources are used effectively.

5 | CONCLUSIONS AND FUTURE WORK

The development of a computer-based system for managing laboratory equipment at SMA Negeri 1 Mutiara has shown significant improvements in efficiency and accuracy. The transition from a manual process to an automated system addresses key challenges, including errors, delays in maintenance, and difficulty in tracking equipment. By utilizing tools like Microsoft Access and Visual Basic, the system simplifies the management of laboratory equipment, allowing school staff to easily input data, categorize items, and generate reports in real

time. The design process focused on creating a user-friendly interface to ensure accessibility for non-technical users, which has been successful in allowing smooth operation. Additionally, database normalization has reduced redundancy, improving data consistency and making it easier to manage equipment records. The system has also improved the speed of data entry, decreased errors, and facilitated timely reporting, which directly enhances laboratory management and overall school operations. While the system is functional and efficient, there are areas for future improvement. One key area is the potential integration of QR code technology for tracking and managing equipment. This could further streamline the equipment management process and improve tracking accuracy. Additionally, implementing real-time monitoring features would provide a more dynamic view of equipment usage and status, which could help in proactive maintenance and better resource allocation. Another area for future development is expanding the system's scalability by adopting cloud-based storage. This would enhance data accessibility, improve security, and offer better backup options. As technology evolves, the system could also benefit from incorporating machine learning or predictive analytics to assist in decision-making processes related to equipment procurement and maintenance schedules. This system could serve as a model for other educational institutions aiming to enhance their laboratory equipment management, ensuring that their resources are effectively managed and always available for students' practical learning activities.

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