

Implementation of Enterprise Resource Planning Informatics Department Education Laboratory

Bekti Suratmanto

Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia
bekti.suratmanto@uajy.ac.id

Andi Wahju Rahardjo Emanuel

Faculty of Industrial Technology, Universitas Atma Jaya Yogyakarta, Indonesia
andi.emmanuel@uajy.ac.id

ABSTRACT

In preparing for the accreditation of units, study programs, and tertiary institutions to achieve a superior rating, Universitas Atma Jaya Yogyakarta (UAJY) often faces challenges in gathering and accessing the necessary resources. These difficulties stem from the accreditation preparation process, ineffective resource management, a lack of data integration, and restricted resource access. Taking advantage of advancements in information technology, UAJY has adopted the ERP Laboratory Information Management System (LIMS) to effectively manage the resources within its educational laboratories. These laboratories serve as a vital support unit in fulfilling the Tri Dharma of Higher Education and play a significant role in enhancing the learning process at the university. Enterprise Resource Planning (ERP) is a strategic tool that can provide organizations with a competitive edge by synchronizing, integrating, and optimizing data. The implementation of ERP LIMS serves as a solution for better resource management within the UAJY Informatics Department's educational laboratories.

Keywords

ERP, LIMS, Accreditation, Educational Laboratory

1. Introduction

With the advancements in information technology, every organization is compelled to integrate technology into its business processes. Without technological support, organizations may encounter difficulties in executing their business operations (Morawiec & Sołtysik-Piorunkiewicz, 2023). The application of information technology has seen rapid development across various industries and sectors, including manufacturing, banking, healthcare, education, and government. Many organizations have started designing and implementing information technology solutions to bolster business growth and overall organizational progress. One particularly significant application is Enterprise Resource Planning (ERP). ERP serves as a strategic tool that can confer a competitive advantage in the market environment by harmonizing, integrating, and optimizing organizational data and processes within a unified system (Jayamaha et al., 2023). The adoption of ERP is becoming increasingly prevalent across different countries and industry sectors (Pasiak & Rahardjo Emanuel, 2021; Qutaishat et al., 2023), including the education sector.

Universitas Atma Jaya Yogyakarta (UAJY) is an educational institution that extensively employs information technology to manage its operations, encompassing both academic and non-academic domains. The primary mission of the university revolves around fulfilling the Tri Dharma of Higher Education, which includes education and teaching, research and development, and community service. For every educational institution, such as a university, it is imperative to undergo an assessment to evaluate the adequacy of its programs in line with the Tri Dharma of Higher Education. One of the factors that determines the suitability of a university, and its study programs is accreditation (Riza Agustiansyah et al., 2017). Accreditation is an assessment process used to evaluate the quality and suitability of a study program and an educational institution (KEMENDIKBUD, 2020). UAJY routinely conducts accreditation procedures for its units, study programs, and the university. Achieving a superior

accreditation status necessitates thorough preparation. To align with UAJY's objectives, each unit within the institution must implement an information system (Supriyono, 2021).

The accreditation preparation process is typically conducted prior to accreditation, which complicates the collection of data and documents (resources) and requires a substantial investment of resources, time, and funds. Furthermore, the requisite documents are not adequately archived (Riza Agustiansyah et al., 2017). Inadequate data processing and integration between systems result in subpar data quality and restricted data accessibility (Zheng & Khalid, 2022). With a robust information system in place, each unit can be seamlessly integrated with one another, and all resources within the unit, study program, and university can be effectively managed. An Accreditation Preparation Team was formed to prepare the Information Systems Study Program of the UAJY Department of Informatics to undergo accreditation which will be carried out by the Independent Accreditation Institute for Informatics and Computers or Lembaga Akreditasi Mandiri Informatika dan Komputer (LAM INFOKOM). This team has the responsibility to prepare all necessary documents and resources, especially for the successful implementation of the Tri Dharma of Higher Education.

Educational laboratories serve as vital support units in universities, fulfilling essential functions (Hadi et al., 2023), including the Tri Dharma of Higher Education and contributing significantly to the advancement of science (Fushshilat et al., 2018). They play a pivotal role in enhancing the learning process within universities (Riswanto et al., 2019), by managing facilities, assets, resources, and all laboratory activities (Eskaluspita, 2020). This research focuses on designing an Enterprise Resource Planning (ERP) system for the educational laboratories within the Department of Informatics. Efficiently managing all resources within an educational laboratory necessitates the implementation of a standardized Laboratory Information Management System (LIMS) compliant with ISO 17025:2017. LIMS is a computerized system designed to collect, process, and store laboratory information (Sun et al., 2021). By utilizing LIMS, it is anticipated that accessing resources such as facility and inventory data, activity scheduling, and other essential resources can be achieved effortlessly and maintained in an organized manner. This system ensures easy accessibility when these resources are needed. It's worth noting that this study does not prescribe specific software or hardware requirements for laboratory use.

Literature Study

One solution for information system planning is enterprise resource planning (ERP). ERP helps manage organizational resources. ERP includes innovative methods (Almajali et al., 2022) for organizations that have high complexity businesses (Hermanto, 2020). In various studies, ERP has been used in various industrial fields, such as ERP adoption for SMEs in Jordan (Lutfi et al., 2022), Malaysia (Jayeola et al., 2020), and Indonesia (Sari & Santoso, 2021) and construction management ERP in Sri Lanka (Jayamaha et al., 2023). Apart from industry, ERP is also applied in the health sector to manage Supply Chain in hospitals (Bialas et al., 2023) and in various educational institutions, such as ERP implementation at Yanbu University - Saudi Arabia (Bamufleh et al., 2021) and Jember University in Indonesia (Andrianto, 2019). ERP allows organizations to manage all business processes, thereby increasing competitiveness (Domagała et al., 2021), optimizing and improving overall performance (Harun et al., 2022) including saving the economy, financial resources, human and material resources, and achieving sustainable economic goals (Mandičák et al., 2022).

According to Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 5 of 2020 concerning Accreditation of Study Programs and Higher Education (KEMENDIKBUD, 2020), accreditation is the process of evaluating and assessing the quality of study programs and higher education institutions. It constitutes a fundamental component of the university's quality assurance system. Higher education accreditation is carried out independently by the National Accreditation Board for Higher Education (BAN-PT). Conversely, the Independent Accreditation Institute (LAM), established by the government, is responsible for accrediting study programs. Upon receiving accreditation, study programs and tertiary institutions are rated as Good, Excellent, or Outstanding, based on the National Higher Education Standards (SNPT).

Educational laboratories, as subunits within a university, play a pivotal role in supporting the realization of Tri Dharma of Higher Education. Consequently, it is essential for these educational laboratories to adopt the International Organization for Standardization 17025:2017 (ISO 17025:2017) as the international benchmark for conducting tests and calibrations. This standard ensures the generation of

valid data and serves as a guideline for attaining accreditation as proficient testing and calibration laboratories. To effectively support the implementation of Tri Dharma of Higher Education, educational laboratories require a Laboratory Management Information System (LIMS) to oversee business processes related to Tri Dharma of Higher Education. The implementation of a Laboratory Information Management System (LIMS) and fostering collaboration among laboratories can significantly enhance the quality and consistency of test and calibration data results. Such collaboration promotes the exchange of information, sharing of experiences, and the harmonization of standards and procedures, all of which can be seamlessly executed (Didah Nur Faridah et al., 2018).

Laboratory Management Information Systems (LIMS) facilitate efficient resource management in educational laboratories. LIMS has been used for applications in a variety of settings, including healthcare laboratories for Covid-19 test data management (Yoon et al., 2022), biosafety (Sun et al., 2021), clinics (Fu et al., 2023), science research centers in Portugal (Bordalo et al., 2021), even the Republic of Indonesia's National Narcotics Agency (Dimas Nugroho & Mursanto, 2019). LIMS also helps manage resources at universities, as has been implemented by Telkom University (Eskaluspita, 2020), Indonesian Education University (Fushshilat et al., 2018), Kufa University – Iraq (Hadi et al., 2023), and Muhammadiyah Metro University – Lampung (Riswanto et al., 2019).

2. Research Method

This research aims to adopt Enterprise Resource Planning (ERP) in the Education Laboratory of the UAJY Informatics Department in the form of a Laboratory Management Information System (LIMS) to manage resources owned by educational laboratories and support the implementation of Tri Dharma of Higher Education. The stages of this research can be shown in Figure 1 going through 5 (five) stages. In the first stage, data was collected through literature studies, observations, and interviews. The second stage is to start planning. The third stage is to analyze the current conditions by designing a business model as well as the systems & technology currently used. In the fourth stage, an architectural model must be designed, which includes data architecture, application architecture, and technology architecture. In the last stage, an implementation plan is made (And & Expert, 2021).

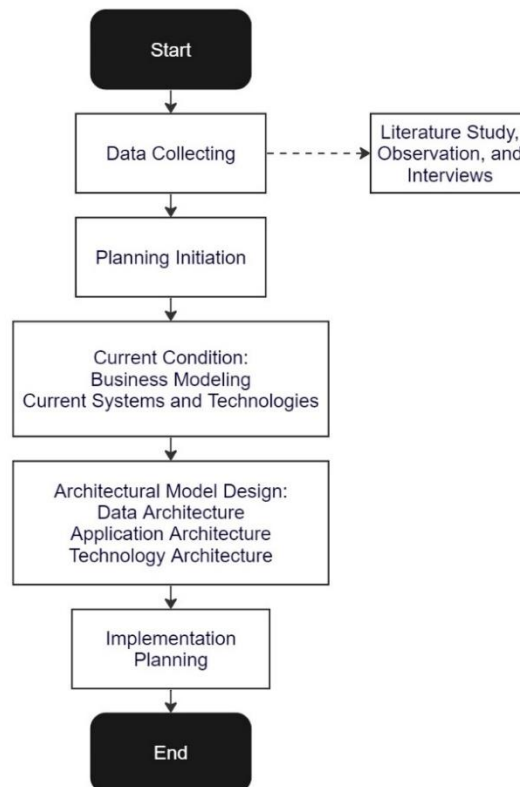


Figure 1. Flowchart Research Method

A. Data Collection

Data is collected to obtain and analyze the needs and operating procedures of educational laboratories. Data was collected through literature study, observation, and interviews. Literature study by exploring several related research journals both nationally and internationally as references. In addition, direct observation of activities taking place in the laboratory and interviews were conducted with laboratory managers in the Informatics Department.

B. Initialization of Planning

This stage begins with compiling a framework by initializing the architectural model plans to be realized. This stage is an important stage because it will analyze the needs of educational laboratories in preparation for Study Program accreditation. In designing ERP LIMS, the waterfall model development method is used. The waterfall model method shown in Figure 2 consists of several stages, namely requirements analysis, design, development, testing, and maintenance (Maulana et al., 2021).

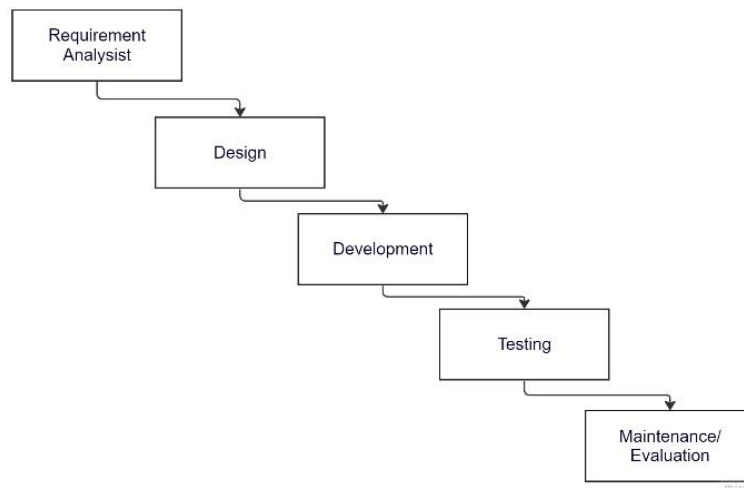


Figure 2. Waterfall Model

The waterfall model stages in Figure 2 begin with analyzing user needs and the system to be developed. The second stage designs the application according to needs and continues with the third stage by creating the application according to the plan and design. After the application is complete, the next stage is testing and maintenance when the application has been implemented.

C. Modeling Business Processes and Current Technology

At this stage information related to the organization's business processes will be collected. By analyzing business processes an organization can initialize or define the organizational structure. The business processes implemented cannot be separated from the systems and technology currently running.

D. Architectural Model Design

This stage includes modeling the data architecture, application architecture, and technology architecture to determine the data needed to support the system, including data entities and business processes. The application and technology architecture determines the appropriate applications and technologies that can be used by educational laboratories that can simplify an organization's business processes.

E. Implementation Plan

The final stage is to create an implementation plan resulting from the system framework that has been created and defined. Implementation can be said to be successful if it is in accordance with the objectives and business processes of the educational laboratory.

3. Result and Discussion

A. Data Collection

The results of literature research, observations and interviews are used to collect and analyze the necessary data. The results are as follows:

1. Little research related to the application of LIMS to support the implementation of Tri Dharma of Higher Education.
2. All inventory data recording, borrowing, and scheduling of activities in the Informatics Department laboratory is still done manually, either with manual notes or with the help of Ms. Excel.
3. The laboratory assistant registration process uses the help of Google Form, and the assistant data collection is done manually using Ms. Excel.
4. There is no application to manage educational laboratory documents such as teaching, research and service documents.

B. Initialization of Planning

Based on the results of literature studies, observations, and business process interviews that run in the UAJY Informatics Department education laboratory in the form of asset/inventory management processes, facility maintenance and lending, activity scheduling, financial administration, management of laboratory assistants, and management of the work of lecturers with students regarding the results output from Tri Dharma of Higher Education in the form of teaching, research, and community service products. In designing ERP LIMS, the waterfall model development method is used. This method consists of several stages, namely requirements analysis, design, development, testing, and maintenance.

C. Modeling Business Processes and Current Technology

In LIMS ERP planning, educational laboratories use the value chain to identify laboratory operations. Teaching, research, and service are the main activities in this value chain. The main activities are supported by infrastructure, human resources, information, and monitoring & evaluation as shown in Figure 3.



Figure 3. Value Chain

Based on the value chain, the 2 (two) main activities, namely teaching and research & service, are supported by a) infrastructure which includes a management system for laboratory facilities, assets and inventory, b) management of human resources in the laboratory in the form of management and registration of assistants. laboratory, c) information in the form of scheduling laboratory activities, d) monitoring and evaluation to monitor and evaluate teaching, research, and service activities in the laboratory.

D. Architectural Model Design

D.1. Data Architecture

Based on the observation and interview process, the Informatics Department's LIMS consists of data entities from business processes. Table 1 below is the candidate data entities that have been obtained.

Table 1. Data Entities

Activities	Entities	Attributes
Inventory Management	Facility	id, facility_name, facility_no, asset_code, brand, specifications, procurement_date, funding_source, price, status, condition, description, image, subunit
Facility Maintenance	Facility	id, facility_name, facility_no, asset_code, brand, specifications, procurement_date, funding_source, price, status, condition, description, image, subunit
	Maintenance	id, check date, examiner_user, academic_year, subunit
	Maintenance Detail	id, maintenance_id, facility_id, check_item, check_result
Lab Assistant Management	Assistant	id, full_name, gender, university, npm, nik, study_program, home_address, domicile_address, email, telephone, account_no, bank_account, account_account, assistant_type, academic_year, photo, attachment_link, notes, description, status, test_date, practice_value, material_value, presentation_value, interview_value, question_answer_value, password
	Presence Assistant	id, assistant, date, in_time, out_time, number of sessions, activities, description, verification_status, notes
Activity Scheduling	Lab Use	id, day, session, academic_year, activity, subunit
	Assistance Schedule	id, day, session, assistant, subunit, category
Facility Lending	Tools Lending	id, academic_year, borrower, identity_no, collateral, subunit, information
	Tools Lending Detail	id, loan_id, facility, loan_date, return_date
	Space Lending	id, academic_year, loan_date, borrower, activity, person in charge, identity_no, contact, loan_facility, attachment, description, subunit
Financial Administration	Finance	id, transaction_name, date, nominal, subunit, category
Evaluation	Assistant and Laboratory	id, academic_year, description, link_form, link_response, subunit
Document Archiving	Document	id, document_name, document_link, document_type, subunit, status

Activities	Entities	Attributes
Teaching Data Management	Teaching	id, lecturer_name, npp, nidn, course, class, rps, syllabus, material, grades
Research and Community Service Data Management	Research	id, lecturer_name, npp, nidn, activity_title, field, activity_location, proposed_year, activity_year, funding_source, amount_of_funds, assignment_sk, member_list, attachments
	Devotion	id, lecturer_name, npp, nidn, activity_title, field, activity_location, proposed_year, activity_year, funding_source, amount_of_funds, assignment_sk, member_list, attachments

Based on table 1, management of facilities or assets is not solely in the form of physical goods and hardware owned by the laboratory. Some laboratories also have special software licenses that are used to support laboratory activities. Software licenses can be categorized as inventory items/assets, so that software license management can be done like managing hardware and physical items owned by the laboratory.

D.2. Application Architecture

Based on table 2, it is described that there are 8 (eight) applications that can accommodate operational activities in educational laboratories, namely inventory/asset management, facility maintenance, laboratory assistant management, activity scheduling, facility lending, financial administration, evaluation, and document archiving. From the front, the applications proposed in this study can be grouped into a large system, namely DataLAB.

Table 2. Application Architecture of DataLAB

Applications	Function	Identified System
Inventory/Asset Management	To manage laboratory asset data in the form of goods, hardware and software licenses used by the laboratory.	DataLAB
Facility maintenance	To record the results of maintenance of facilities in the laboratory.	
Lab Assistant Management	To manage data, registration and attendance of laboratory assistants.	
Activity scheduling	To record scheduling of activities in the laboratory, routine use of laboratory space for lectures and student activities, and scheduling of assistance.	
Facility Lending	To record every transaction for borrowing equipment and laboratory space.	
Financial administration	To record laboratory financial/cash data.	
Evaluation	To record evaluation forms and responses to evaluations of laboratory infrastructure and laboratory assistants.	
Document Archiving	To manage and record documents in the laboratory, including teaching, research and service documents.	
Teaching Data Management	To manage and record teaching data in the laboratory in the form of courses per lecturer, RPS, materials, syllabus and grades.	

Applications	Function	Identified System
Research and Community Service Data Management	To manage and record research and service data carried out by lecturers and laboratories.	

D.3. Technology Architecture

ERP design requires a technology architecture that involves hardware and network so that the system can run. Figure 4 shows the LIMS DataLAB technology architecture which consists of client's devices, switches, and routers. Client's devices can consist of PCs, laptops, or smartphones.

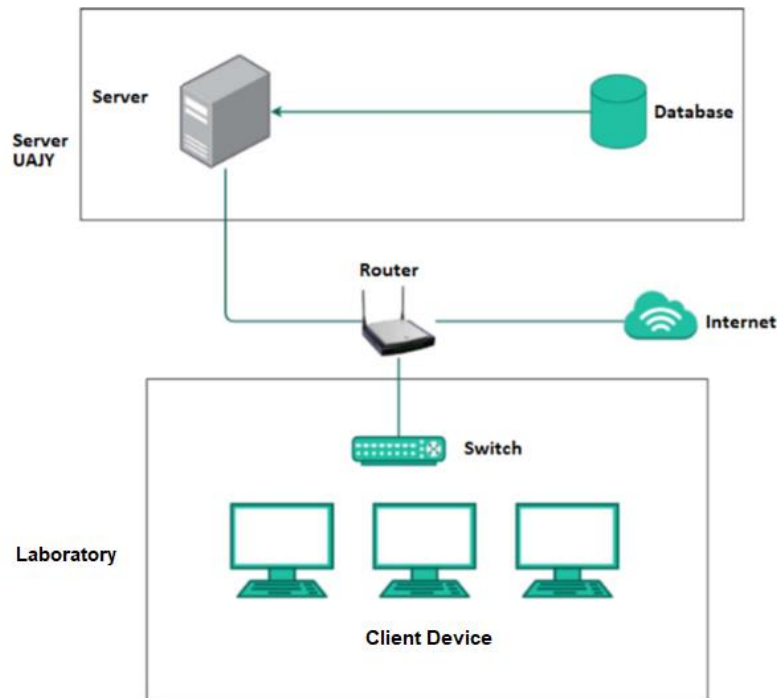


Figure 4. Technology Architecture

E. Implementation Plan

The DataLab LIMS implementation plan will go through several stages:

E.1. Data Migration

Data migration is carried out after the DataLab LIMS has been developed. Data migration includes deploying applications and databases to department/faculty servers and manually importing data that has been created into LIMS DataLab.

E.2. User Training

Training laboratory users/managers on how to use and functionality of DataLab LIMS. This training involves system navigation, data entry, workflow understanding, and general problem solving. Users are expected to have knowledge of the system and be able to use it effectively.

E.3. Monitoring and Evaluation

Once the DataLab LIMS is implemented, regular monitoring will be carried out to see system performance, functionality working properly, and compliance with laboratory requirements. When problems occur, they will be identified quickly so that the system runs smoothly.

E.4. Care and Maintenance

This process will establish a care and maintenance schedule that includes data integrity monitoring, system updates, and necessary fixes for problems that arise. In the medium term, it is possible to expand the functionality according to future laboratory needs.

E.5. Integration with Other Systems

Review the possibility of integrating LIMS DataLab with other systems used in laboratories, departments/faculties, and universities to gain efficiency and interoperability between these systems. This also allows DataLab LIMS to collaborate with external vendors.

4. Conclusion

Based on existing research, LIMS ERP has been widely used for laboratories in various fields, be it health, industry, or education. With the implementation of LIMS DataLab in the Education Laboratory, the Informatics Department can provide solutions for managing laboratory resources. With well-managed resources, the accreditation preparation process can run smoothly. The resources needed can be accessed easily, especially those related to teaching, research, and community service which are the Tri Dharma of Higher Education. The limitation in this study is that LIMS Datalab regulates the laboratory needs of the Informatics Department in general and does not regulate specific software or hardware needed and used by laboratories. After the development and implementation of LIMS DataLab has been carried out, future research can explore the evaluation of the success of implementing LIMS DataLab, increasing productivity and efficiency, as well as data management and security.

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