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Management System Design of Scheduling of Laboratory Equipment Based Computerized

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ABSTRACT

The management of laboratory/workshop equipment is crucial to achieve the optimization of system accessibility, accuracy, timeliness, and sustainability. The information system for the laboratory management is an information provider that supports decision-making processes and deployment of data sources. This paper aims to design and analyze a system scheduling information of laboratory/workshop equipment. The research method consists of two stages: (1) analyzes previously the scheduling management system of laboratory equipment and design a new improving its system. The method used flow system of arrival pattern, which the job priority rules First Come First Served (FCFS). The stages 2 were a design of scheduling equipment management system for the laboratory/workshop based computerized. The design of the information system was used program language of the PHP (Hypertext Pre-processor) and MySQL (My Structure Query Language) as a database. This system design was integrated between admin and users (students, technicians and lecturers). This research advantages were generated an information application system design to manage the scheduling data of laboratory equipment. Hence, it can facilitate the management laboratory/workshop to determine operational labor in a much easier manner yielding more accurate and faster results.

KEY WORDS: *Design, Equipment Scheduling, Information System, Laboratory Management.*

1.0 INTRODUCTION

The laboratories in institution have an essential function such as development, research, and educational [1]. According to Pandermarakis *et al.* (2012) [2], the function of laboratory can be as a basic education and training, reverse engineering, quality control and pure scientific research. The engineering educational laboratory type: hands-on laboratory with real instruments, simulated or virtual laboratory and remote or distributed learning laboratory [3]. An activity in laboratory is designed to enhance the practical and experimental skills, experience and expertise directly with real materials and phenomena, equipment, tool, apparatus, machinery etc. Sub sequence, a laboratory is consisted of many equipment, instrument, tool, apparatus, machinery etc. Hence, the scheduling of the equipment is crucial contribution to make effective and efficient of laboratory activities. According Maslaton (2012) [4], generally the laboratory used a conventional tools for scheduling equipment such as MS Excel. That may lead to time consuming, potentially human error and complicated to tracking the data report. Therefore, it is needed a management system based computerized to manage the scheduling equipment in laboratory.

Laboratory management can be defined as a strategy to achieve the goal of the laboratory optimally through planning, organizing, utilization and controlling all laboratory resources. The effectiveness of laboratory management resources is significant to guaranty attention from higher education, institution administrators, and certification bodies [5]. The laboratory education resources can be the instructors, students, laboratory assistants, technicians and laboratory facilities such as space, tools and equipment. The laboratory management system is needed to management of laboratory materials and equipment that use of materials and tools for routine practice, machine condition, state material inventory, practices maintenance etc. A computerized scheduling can be a solution to increase the laboratory management system performance [4].

Bedworth [6] defined purpose of scheduling activities such as improving of resource use or reducing the waiting time, reduce inventories or the number of jobs waiting in the queue and assist

in the decisions on capacity planning. Some priority rules for scheduling are [7]: First Come First Served (FCFS), Shortest Processing Time (SPT), Shortest Total Processing Time Remaining (STPTR), Earliest Due Date (EDD) and Fewest Operation (FO). The scheduling implementation in the laboratory activities specified in using of the equipment or machinery, doing job or work sheet practicum, borrowing equipment or machinery, order material practicum, maintain equipment or machinery. The of laboratory equipment for education can be a complex job that needs to support a scheduling based information technology for easy accessible to the instructors, students, laboratory assistants, technicians and person in charge to manage the laboratory. A good and effective scheduling provides a foundation for the effective and efficiently utilization and attaining on the laboratory activity or operational. Therefore, this research objective is to design and develop a system scheduling of laboratory/workshop equipment based information technology.

2.0 LITERATURE REVIEW

2.1 Scheduling

The scheduling is the timing of the operation, which encompasses allocating facilities, equipment and manpower, and determines the order for the execution of an operation. The scheduling in laboratory education is required to minimizing the processing time, waiting time subscriptions, and inventory levels, as well as the efficient use of facilities, labor, and equipment. Blazewicz *et al* [8] stated the priority rules were favored for scheduling solution due to low time complexity and easy implementation. The priority rules and their description can be seen in Table 1 [8].

Table 1: Rules of priority in scheduling [8]

Rule	Description
SOT (shortest operation time)	An operation with shortest processing time on the considered machine.
LOT (longest operation time)	An operation with longest processing time on the machine considered.
LRPT (longest remaining processing time)	An operation with longest remaining job processing time.
SRPT (shortest remaining processing time)	An operation with shortest remaining job processing time.
LORPT (longest operation remaining processing time)	An operation with highest sum of tail and operation processing time.
Random	The operation for the considered machine is randomly chosen.
FCFS (first come first served)	The first operation in the queue of jobs waiting for the same machine.
SPT (shortest processing time)	A job with smallest total processing time.
LPT (longest processing time)	A job with longest total processing time.
LOS (longest operation successor)	An operation with longest subsequent operation processing time.
SNRO (smallest number of remaining operations)	An operation with smallest number of subsequent job operations.
LNRO (largest number of remaining operations)	An operation with largest number of subsequent job operations.

2.2 Information System of Laboratory Management

Definition of the system is a human system or machine integrated to provide information to support function information. According to O'Brien & Marakas [9] a system is a network of interrelated components, gathered together to perform an activity or to accomplish a particular goal. The system uses hardware and software computer, procedure guidelines, decisions, and databases. According to Hasan et al [10] management information system is computer-based information that takes data from internal systems as management-oriented reporting to support managerial decision making. Furthermore, management information system is a collection of hardware, computer software, procedures, documentation, forms and people in an organization that responsible to distribution and processing of data and information, so that useful for management.

Laboratory information system is a system that manages the information data from a laboratory, which the data is stored in order to be efficiently. This information system covers all of existing activities in the laboratory such as availability of equipment, anyone who using that equipment, the data input and output of the laboratory equipment, data administrative and archiving, so forth. All equipment on laboratory must have documentation for activities related to the equipment such as a complete record, scheduling and documentation for laboratory equipment [4]. Advantages of the laboratory information system are [4,11]: easy in terms of laboratory data archiving, data searching, easily monitored by management laboratory, facilitate administrator and user to input data to the server that can be easier than inputting data manually.

In designing the system there are three steps being taken, namely the design process, database design and interface design [11].The database design is used to define entities, attributes, and relationships occur between each entity [11]. The database is a collection of data that is linked together, and an overview of the data that is designed to meet the information needs of an organization. The database data is stored in an integrated manner. According to Connolly and Begg (2005) [12] DBMS (Database Management System) is a software that allows users to define, create, maintain and control access to the database system. A system design is better to integrate the data file to a file so that it can serve a variety of different users. The DBMS allows for establish and rejuvenate the files, select and sorting of data and generate reports.

2.3 System Development Model

According to Pressman (2010) [11] stated that one of method for design and development of a software is waterfall model. The waterfall model comprises a series of tasks that follow a regular pattern and starting from top to down as shown in Figure 1. Other method is incremental model [11] that can be seen in Figure 2. The model of incremental process can do the working parallel, phase one should not wait other stages.

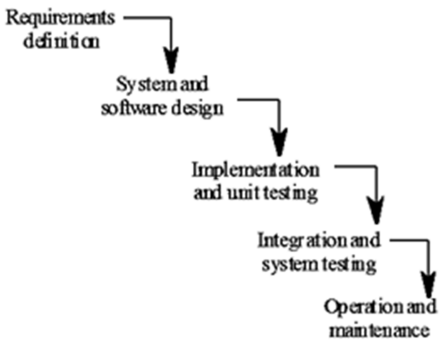

Figure 1: A waterfall model for development of an information system design [11]

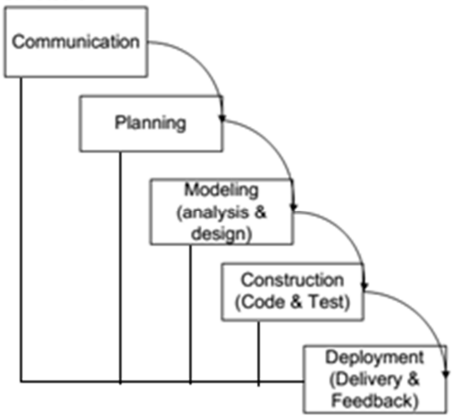

Figure 2: The incremental model for development of an information system design [11]

2.4 PHP and MySQL

The PHP is the standard language used in the world of websites that used script, which placed inside the web server. According Kadir [13], the PHP makes application development process becomes easier due to: (a) Script (program code) is integrated with the HTML file, so the developer can focus on its web appearance, (b) No need compiling and linking process, (c) The object-oriented, (d) Programming syntax is easy to learn, and (e) Capability to integrate different database servers. The PHP supports access to existing databases by free or commercial. The databases include MySQL.

The advantages of MySQL database by Denton and Peace [14]: database server is not paid, capable of storing very large data, supported by the ODBC driver, which can be accessed using any application, database encryption password (quite safe because it has a password to access it) and the database server is a multi-user.

3.0 METHODOLOGY

Research carried out using a method that consists of analysis and modeling system such as materials or data research, analysis and design approaches; implementation and testing of the software application. A flowchart design methodologies of laboratory equipment scheduling based management information system can be seen in Figure 3.

This research was conducted a case study in Production Laboratory of Mechanical Engineering Department, Universitas Riau, Indonesia. The data were collected in that laboratory: equipment, machinery, tools and material. In the design and analysis system information for managing data scheduling of laboratory equipment adopted the incremental model development [11]. The model requires a systematic and sequential approach in software development starting from the stage of planning, analysis, design and operation of the system. Because production laboratory of Riau University has a job as dynamic scheduling, therefore the rules of priority method adopted the First Come First Served (FCFS). Implementation of the system was done with the following specifications: operating system of Windows 10; processor used Intel Core i3; memory of 4GB; programming language used the PHP (Hypertext Preprocessor); and the database used MySQL (Structured Query Language).

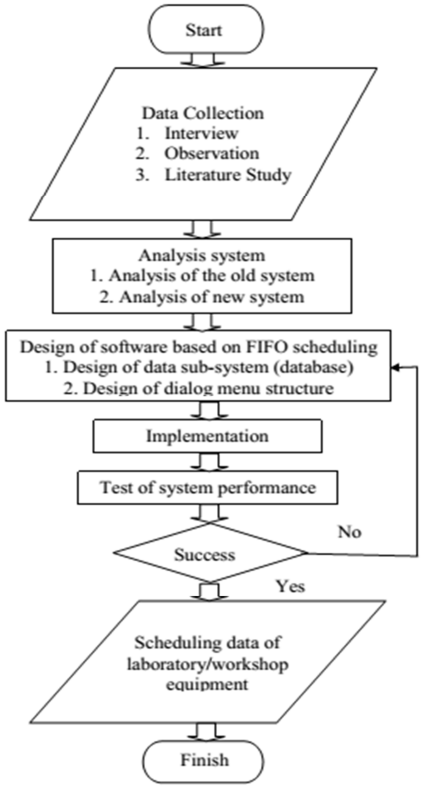

Figure 3: Flowchart of development of laboratory equipment scheduling based information management system

4.0 RESULT AND DISCUSSION

This research was developed a scheduling management of equipment laboratory based information system as well as the process of recording existing equipment in the laboratory of Mechanical Engineering, University of Riau as a case study.

Based on the operational management of equipment in the case study laboratory that was used a conventional system. Sub-sequence, it revealed a long process, the potential for human error and loss of such equipment, damage or un-usable. The equipment on loan and that has been restored just recording into Microsoft Excel in an un-certain period. Besides, it has not structured scheduling system so the lack of control of the equipment in the laboratory. Consequences, it was difficult for a student or laboratory management to manage activities that related to laboratory equipment data information. Therefore, the old system has not efficient and optimal.

The new system was developed using a computer-based application system for scheduling laboratory equipment. An analysis of the new system consists of sub-data system and sub-system dialog. Sub-data system was a database containing data relevant to the situation and managed by the software. The database development was described in the form of Entity

Relational Diagram (ERD), which serves as a reference in designing the database. Sub-dialog system: was used to communicate with the users. The analysis of sub-dialog system was described by Data Flow Diagrams (DFD).

The new system provided the convenience in scheduling process equipment, process equipment borrowing and the return on borrowed equipment. The advantages of this new system were to minimize errors that occur and recorded correctly. Method of the First Come First Served (FCFS) was adopted that sort jobs by date comes from a batch job to be scheduled, the order was then used as the basis for determining jobs prioritize in advance for scheduling of laboratory equipment. It can be seen in Figure 4, the scheduling system flowchart for developing of laboratory equipment activity.

Use case diagram of the scheduling system equipment in the Laboratory of Production, Mechanical Engineering, University of Riau that can be seen in Figure 5. The use case scenarios of system equipment management can be seen in Table 2. Then, the Entity Relational Diagram (ERD) and Data Flow Diagrams (DFD) were used to describe the relation and flowing of the data along with all the attributes in the Table 2. Finally, the class diagram that a diagram was used to show some of the classes, which exist in the system of the software developed.

The program application for Scheduling of Laboratory Equipment can be access by Admin and Users. Main menu of the system consisted of home, machine and material, scheduling machine and material, and database of scheduling equipment, it can be seen in Figure 6. The home menu was displayed workshop rooms and warehouse that the equipments (machine and material) were placed. If users entered to the scheduling menu would be appeared the menus of offering machines, the confirmation of borrowing, borrowing list, list of return and report borrowing the laboratory equipment as be seen in Figure 7.

Table 2: The scenario of use case

Use Case	Description
Login admin and user	Admin and user must enter a username and password to login into the system
Data equipment / machinery	A data management of machinery and equipment processes
Data material	A data management process of material
Confirm loan	A confirmation process of borrowing done by the students
Data loan	A data management processes borrowing
Data recovery	A data management process refund
Data stock of material	The process of managing the amount of the substance / material
Report	The process of data reporting and print out

Then, the system informed the form of loan and database machines as depicted in Figure 7. The main menu of admin system on scheduling equipment i.e. lending machine menu that was divided into three based on the needs of its users: common user, practicum user and the final project user. Whilst, the borrowing and refund processes was conducted by the users, it can be seen in Figure 8. The materials to be used by the student were needed to select the menu of material usage (Figure 8). Therefore, the report of scheduling equipment result can be print that was depicted in Figure 9.

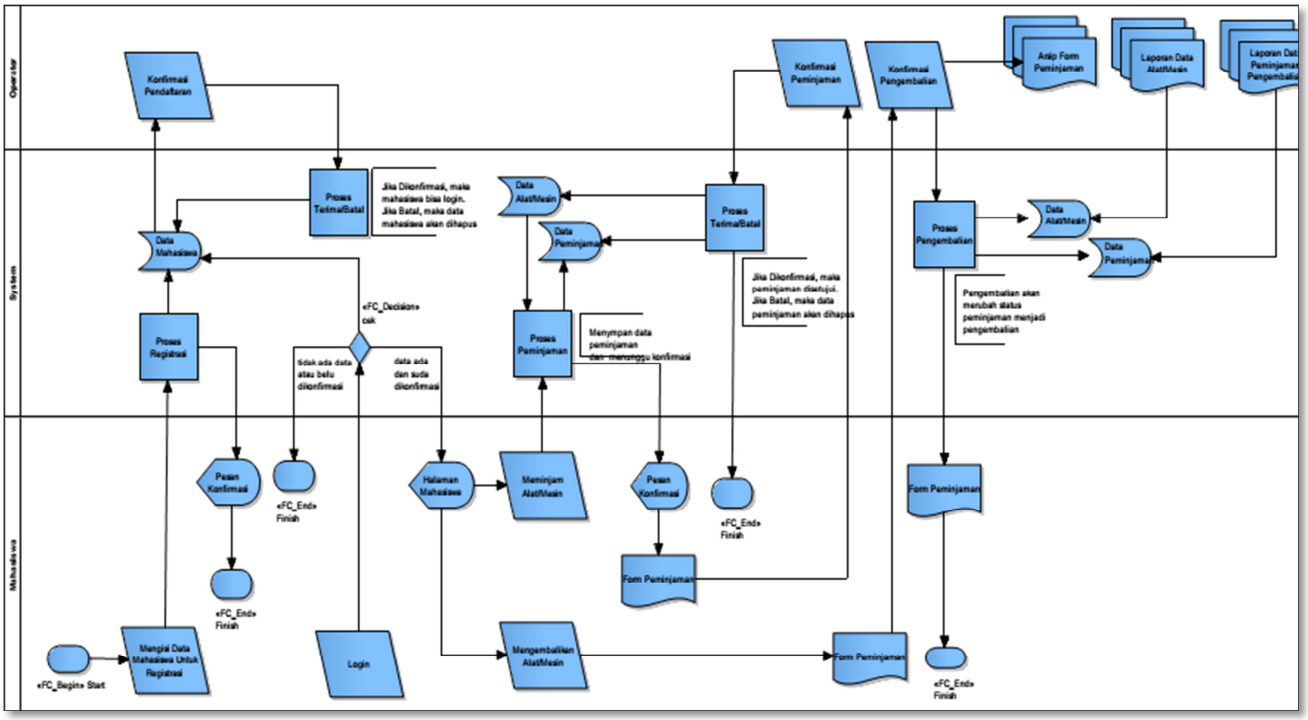

Figure 4: The flowchart of scheduling laboratory equipment

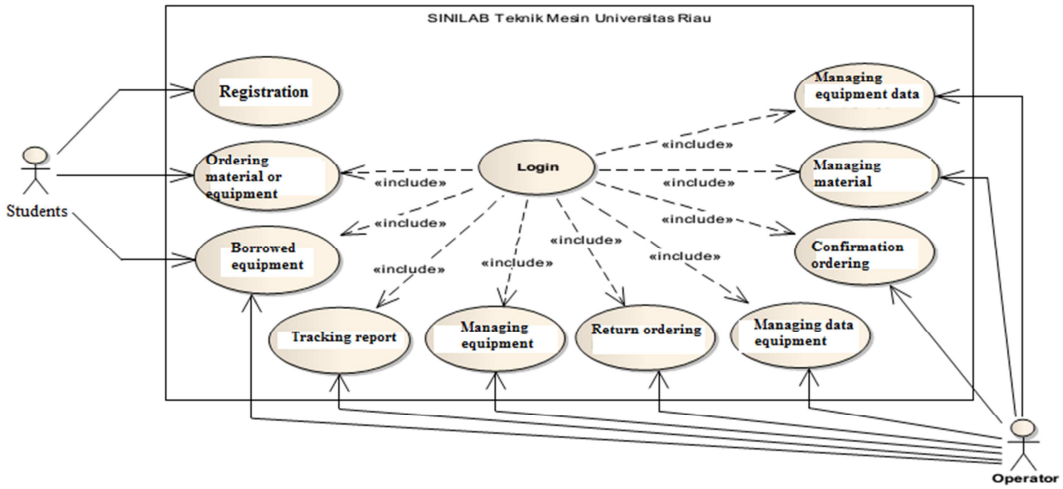

Figure 5: The use case diagram

Figure 6: The main menu of application software for scheduling of laboratory equipment

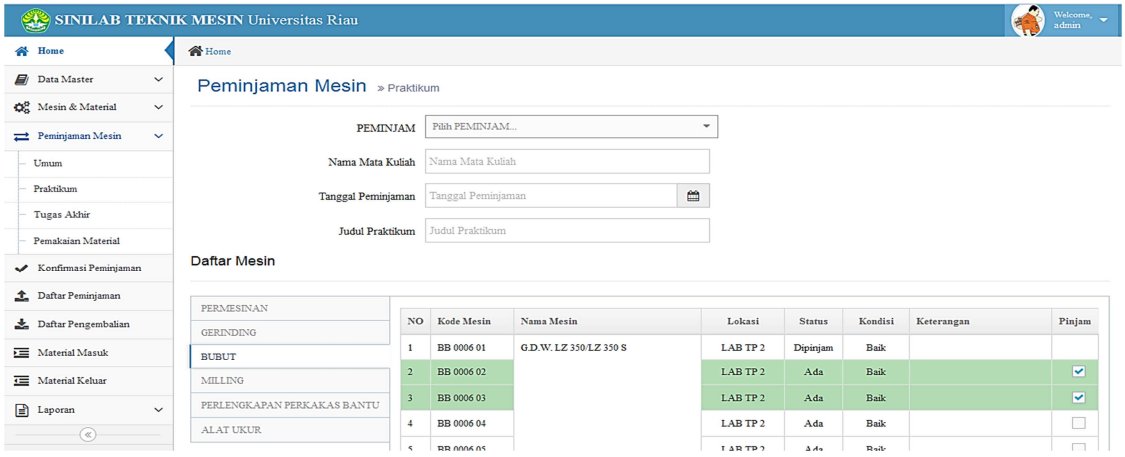

Figure 7: The displaying menus of borrowing laboratory equipment

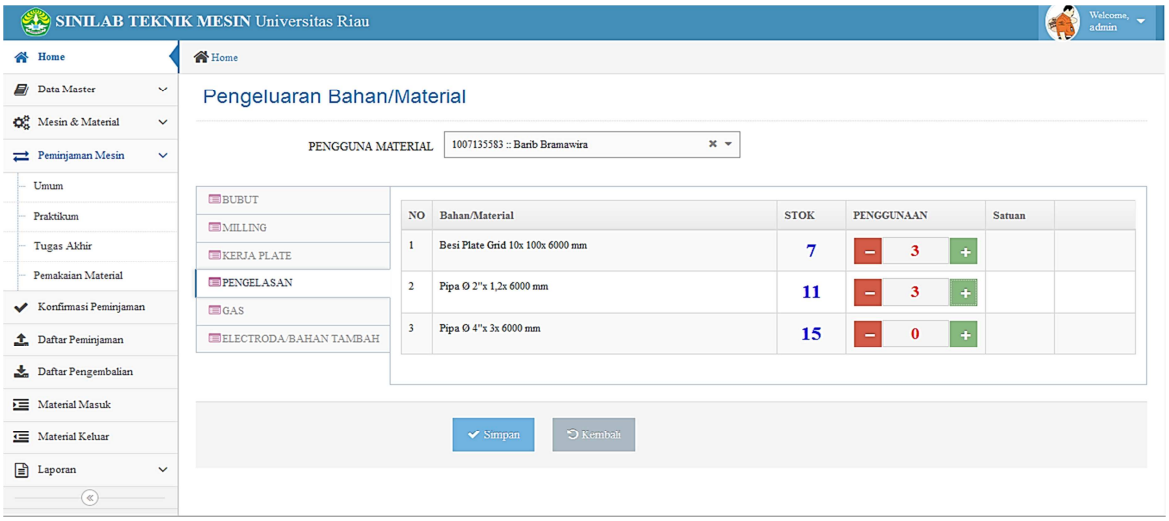

Figure 8: The menu of material order or usage

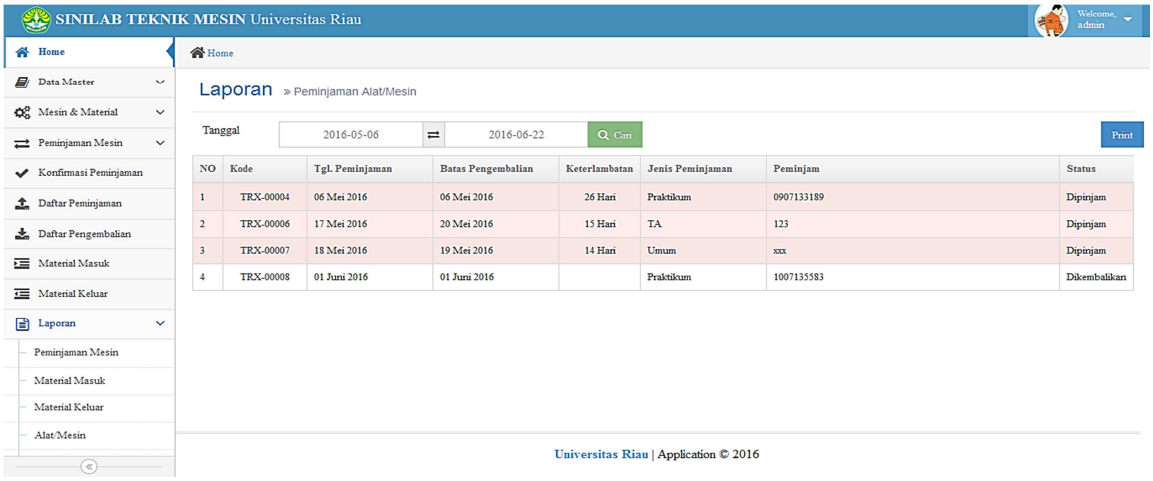

Figure 9: The report of scheduling of laboratory equipment

5.0 CONCLUSION

The management of laboratory equipment based computerizing system is very helpful in the process of learning and teaching as well as makes it easier to obtain availability information and scheduling system of equipment. The objective this research is to design and develop a system scheduling of laboratory /workshop equipment based information technology. This research used the dynamic scheduling of First Come First Served (FCFS) to determine the priority for decision making. The application program was developed by using MySQL as database and PHP (Hypertext Preprocessor) as a programming language. The case study was conducted in laboratory of the Mechanical Engineering, Universitas Riau, Indonesia. According testing of the developed software was obtained an optimal performance for the management system of scheduling equipments in Mechanical Engineering Laboratory, University of Riau. The new system provided a faster, efficient and accurate of equipment for data management system.

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