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Back-End development on Laboratory Information System in Universitas Riau

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***Abstract*—Laboratories usually have different tools, materials, documents, and a lot of other content. At the University of Riau, especially the Faculty of Engineering, it is filled with many laboratories. Starting with a computer network laboratory and chemical laboratory, machine laboratory, and many more. Currently information about laboratories cannot be found on the internet, and it is still difficult to access information about laboratories. This research focuses on creating a back-end system that can later be implemented in the development of a laboratory information system. This development process uses the V-Shaped model as a reference in the manufacturing stages. The system that has been made will be tested using the unit testing, integration testing, and system testing methods with ISO 25010 as a reference standard in determining the quality of the tests carried out. The results of testing the system obtained very good results with A results on reliability, maintainability, and security testing. In testing the efficiency of the system in getting a response time 80ms average on each page. White box testing also obtained results that all the features and data in the system were functioning and matched as they should.**

Keywords—Back-End, Laboratory, V-Shaped Model

I. INTRODUCTION

Today's information technology has developed rapidly and has almost become a necessity in both companies and educational institutions. This also indirectly encourages companies and educational institutions to use information systems. In educational institutions, many information systems are used, such as lecture portal information systems, attendance, and many more. One example is the laboratory information system. Information System is a system that is designed using various processes and algorithms with the aim of disseminating information between system users. Information systems can also provide information in which there is interaction between users, processes, algorithms, and technology [1]. While the laboratory is a place that supports research and practicum activities [2].

At the University of Riau, especially the Faculty of Engineering, it is filled with many laboratories. Starting with a computer network laboratory and chemical laboratory, machine laboratory, and many more. Currently information about laboratories cannot be found on the internet, and it is still very difficult to access information about laboratories. In addition, without an information system it also causes laboratory management to be less efficient because it is very time and energy-consuming especially when the tool you are looking for is not available or is being used by someone else. In addition, the speed of laboratory services also depends on how many visitors and managers are at the location. And not infrequently there are also many visitors who want to ask for the same thing which should be easily handled if there is an information system regarding the laboratory.

This research focuses on creating a back-end system that can later be implemented in the development of a laboratory information system as one of the solutions to the above problems. In the process of making the backend of an information system, various problems are often found, starting from creating a structured and efficient database in the relationship between each table. Besides that, there is also a problem from the security section whether the system can be injected with various other programming languages, The functions needed, and also connecting them with existing data are also a challenge in the process of making this laboratory information system backend.

It is hoped that from the design of this Information System, the laboratory management system within the Faculty of Engineering, University of Riau can be managed properly. And also with this Laboratory Information System, it can introduce laboratories in the Faculty of Engineering, Riau University to the wider community and other educational institutions. And it is also hoped that the existence of an information system in the Faculty of Engineering, Riau University can become a benchmark for laboratory information systems in other faculties.

II. METHODOLOGY

A. V Shaped Model

This system was designed using the V Shaped Model, which is also known as the Verification and Validation model.

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The V-Model is one of the SDLC models which is a variation of the Waterfall model and is described in the form of V [3]. This method was chosen because it was deemed suitable to be applied to this information system. The V – Shaped model used in this laboratory information system consists of 7 stages as can be seen in Figure.1.

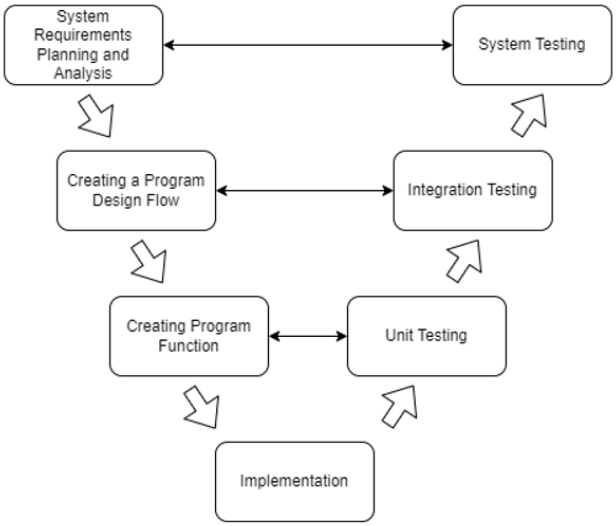

Fig.1. V Shaped Model

The first stage is System Requirements Planning and Analysis. This requirement can be functional as well as non-functional. For functional requirements, for example, the system must have a data display function, must have a loan form, and so on. As for non-functional requirements, for example, whether the system is attractive, easy to understand, and so on. Creating a Program Design Flow stage contains the program workflow, combination of units and is also paired with Integration Testing. Creating Program Modules stage contains the units needed to run the system, usually individual and paired with unit testing. Implementation is the stage that implements the steps that have been passed before, at this stage we combine units in order to form an architecture according to the needs of the system. After implementation, unit testing is carried out to ensure the units to be used are functioning as they should without having fatal errors in the process. Integration testing is carried out to test the relationship/combination between units, even though the unit is running as it should, it does not guarantee that after being combined there will be no problems. Therefore we carry out integration testing to avoid fatal errors in the system workflow. System Testing is carried out to ensure that the system created meets the needs and functions as it should.

B. Testing

The stage that is carried out after the entire system has been designed is to carry out tests to ensure the system that has been designed is in accordance with the needs. To ensure whether the software created is of good quality, the benchmark that has been made by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), namely ISO 25010, will be used. To test whether the software is in accordance with the standards, several test methods will be used as a measuring tool whether the software is in accordance or not. Because this research is only on the backend, only a few points are taken from the 8 aspects. Functionality Suitability was tested using Whitebox testing. White box testing is a test carried out on software by analyzing and examining the internal structure and code of the software [4]. Performance Efficiency was tested using wept to give an idea on response time that needed by system to load properly. Wept gives an easy to understand and much detail on test result run by the system. Compatibility was tested using manual test by running the system on many browsers on many devices available at the moment to check if the system can run on many devices with different OS with no problem. Security and Maintainability was tested using SonarQube. SonarQube is an open-source platform for assessing the quality of a program's source code. This assessment covers many points including code design, duplication, potential bugs, maintainability, and many more. This platform can be used to assess more than 20 programming languages [5].

III. Result And Discussion

A. System Requirement and Planning

Functional requirements are the various requirements needed for a system to run, these requirements can discuss the hardware and software needed. Requirements can be written in the form of a list that can describe the various requirements needed for the system to run as it should [6]. The following are the functional requirements for this laboratory information system.

Table I. Functional Requirement

Number	Functional Requirement
1	User can search with keyword and filters
2	Form for tools borrowing procedure
3	Users can view data about tools
4	Users can view data about activity
5	Users can view data about document
6	Users can view data about laboratory
7	Admin can log in using email and password
8	Admin can add and delete tools
9	Admin can add and delete activity
10	Admin can add and delete document
11	Admin can add laboratory
12	Admin can change password
13	Admin can edit borrowing form from user

Non-Functional Requirements (NFRs) are a set of specifications that describe the operational capabilities and limitations of a system and enforce its functionality [7]. The following are the non-functional requirements for this laboratory information system.

B. Program Design Flow

A use case diagram is a diagram that displays interactions that can occur between system users and the system itself. The use of use case diagrams is very important in organizing and modelling the actions of a system.[8]. In this Use Case Diagram, the interactions between the admin and visitors are described as actors with the system. Visitors can view the appearance of the website, conduct searches based on the departments and services they want to find, and fill out the form for borrowing tools. Admin can view and modify the data in the system and confirm requests for visitors who want to borrow tools from the laboratory. Table relationships are a collection of several tables that describe data from each database table and the relationships between tables. The relational data model uses a set of two-dimensional tables

(which may be called relation tables) where each table is composed of a number of rows and columns [9].

TABLE II. NON-FUNCTIONAL REQUIREMENT

Parameter	Non-Functional Requirement
Availability	Accessible and available any time
Reliability	All function can run without fail
Ergonomy	Easy to use
Portability	Accessible on desktop & mobile & available any time
Memory	At least 2GB of ram
Response Time	Under 10 seconds per page
Safety	Using password encryption
Security	No security risk on testing
Communication Language	Using Indonesian Language

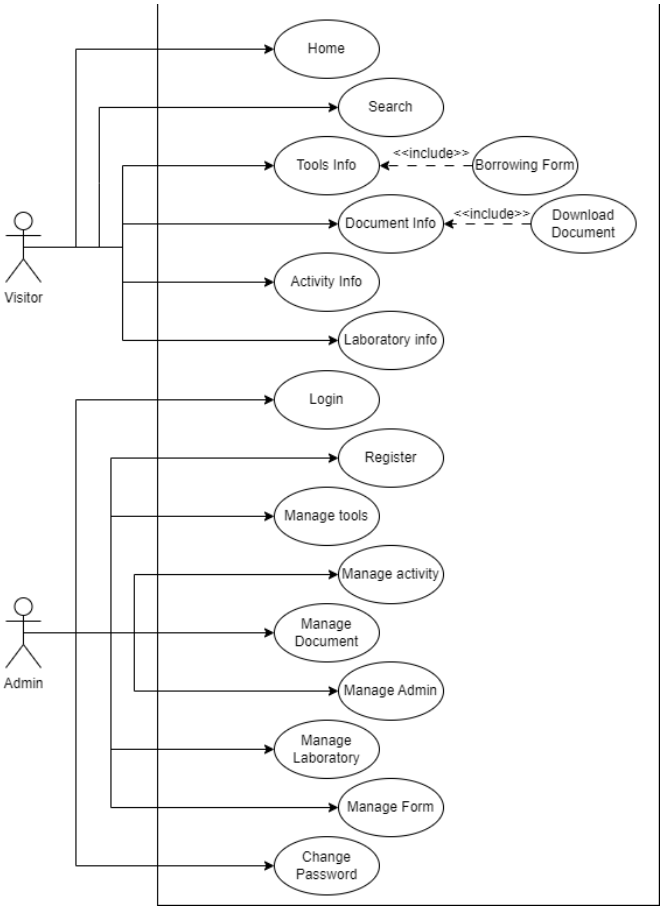

Fig. 2 Use Case Diagram

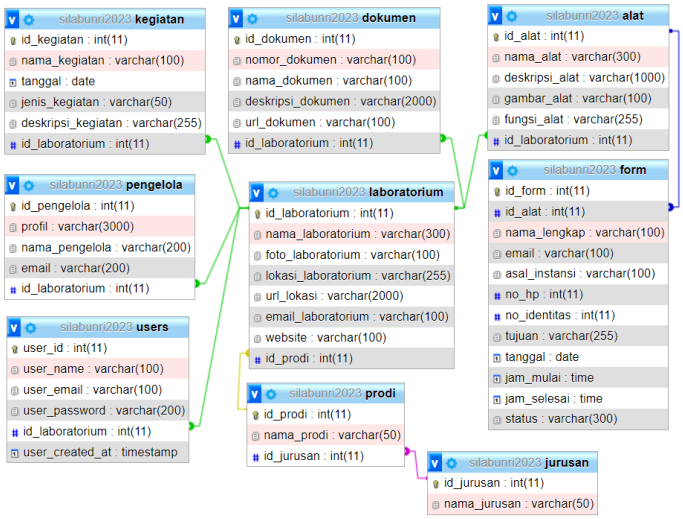

Fig. 3 Entity Relationship

In this Laboratory Information System design it is estimated that there will be 9 tables where the main table has a relationship with almost every other table, and that main table is named laboratory table. In laboratory table there are various data such as name, photo, location, email, manager, cell phone number, and website. Apart from that, id_laboratory is also used as the primary key and id_prodi as a foreign key. For other tables, it also contains data about laboratories such as the tools table which contains a list of tools which will be connected to the laboratory table with id_laboratory as the primary key.

There are also document tables that contains list of document, activity tables that contain list of activities that have been carried out or that will come, form table that contain all the data that user have submitted, staff table contain all the staff that manages the laboratory, study program tables, and majors tables. Users table contain all the account that used by the admin so they can log in and modify the data within the system. This table contains list of data such as user_id, user-_name, user_email, user_password, and id_laboratory as a foreign key.

Flowchart is an illustration of the workflow in solving problems used in the system. Flowcharts can help users understand difficult logical arrangements. flowcharts can facilitate interaction between people involved in the system creation process [10]. Flowcharts are made not only to make it easier for people who create projects, but also to facilitate the process of communication between people involved in the project.

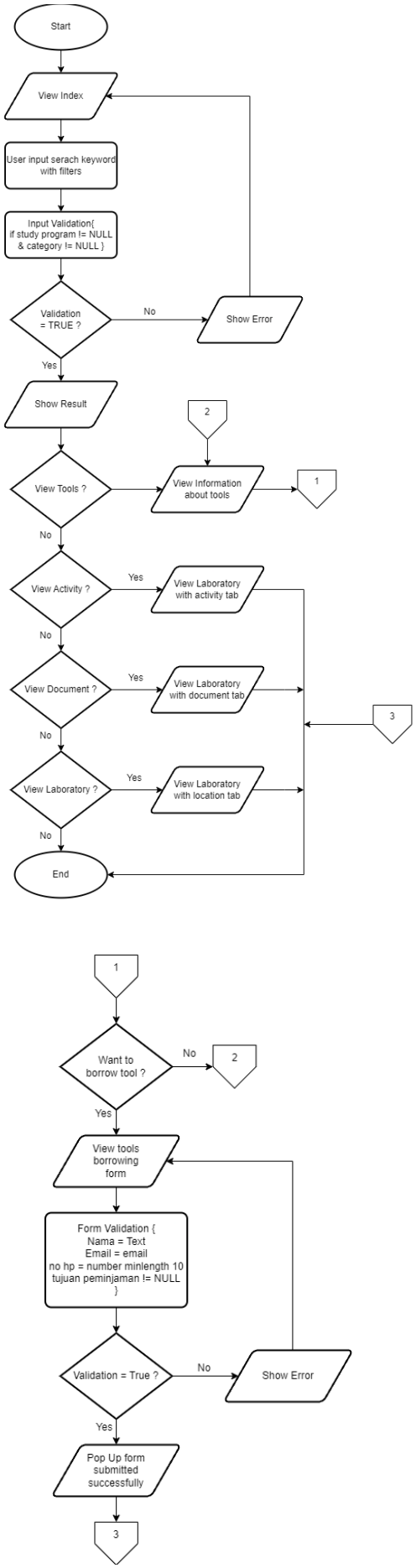

Fig. 4. Flowchart

C. *Creating Program Functions & Implementation*

Based on the requirements and design flow of the program, various modules are designed that are needed so that the program can work as it should. CodeIgniter 4 is used to make the process of creating easier. CodeIgniter is a framework that is often used by programmers in developing a website system using the PHP language, currently version 4 is the latest version in this framework. Framework makes program development no longer needs to be done from scratch because the framework already contains many libraries that can be used. The libraries contained in this framework usually contain a simple display and logical functions that are often used in website development, with many libraries owned, it can indirectly make developers more creative and can minimize the number of lines of code in the program [11]. The following will show some of the existing modules in the program.

```
public function cari()
{
    $jenis = $this->request->getGet('jenis');
    $prodi = $this->request->getGet('prodi');
    $cari = $this->request->getGet('cari');
    switch ($jenis) {
        case 'Alat':
            $model = new alat();
            $model2 = new laboratorium();
            $model3 = new prodi();
            switch ($prodi) {
                case 'Semua Prodi':
                    $data['prodi'] = $model3->listprodi();
                    $data['data']= $model->like('nama_alat', $cari)->getAlat();
                    $data['laboratorium'] = $model2->listlab();
                    $data['pager']= $model->pager;
                    return view('hasil_pencarian', $data);
                    break;

                default:
                    $data['prodi'] = $model3->listprodi();
                    $data['data']= $model-> like('nama_alat', $cari)->where('prodi.id_prodi', $prodi)->
                        getAlat();
                    $data['laboratorium'] = $model2->listlab();
                    $data['pager']= $model->pager;
                    return view('hasil_pencarian', $data);
                    break;
            }


        case 'Dokumen':
            $model = new dokumen();
            $model2 = new laboratorium();
            $model3 = new prodi();
            switch ($prodi) {
                case 'Semua Prodi':
                    $data['prodi'] = $model3->listprodi();
```

Fig. 5. Search Function

Search function which will take the input value from the user and will be processed to filter the data which will later be forwarded back to the user.

```
public function info_dokumen(){
    $model = new laboratorium();
    $id_laboratorium = $_GET['id_laboratorium'];
    $data['laboratorium']= $model->getlaboratorium($id_laboratorium);
    $data['dokumen'] = $model->listdokumen($id_laboratorium);
    return view('Info_dokumen',$data);
}

function download($id)
{
    $model = new dokumen();
    return $this->response->download('filedokumen/' . $id, null);
}
```

Fig. 6. View and Download Document

View function that will display the document data from the database for user to see, and download function make user can save the document file.

```php
public function admin_form_persetujuan(){
    $model = new formpeminjaman();
    $model2 = new alat();
    $session = session();
    $user_laboratorium = session()->get('user_laboratorium');
    $data['data']=$model->where('alat.id_laboratorium', $user_laboratorium)->pengajuan();
    return view('admin/form_persetujuan', $data);
}

public function update($id_form)
{
    $model = new formpeminjaman;
    $session = session();
    $model->update($id_form, ['status'=> $this->request->getPost('status')]);
    $session->setFlashdata('msgsuccess', 'Data Berhasil Diupdate');
    return redirect()->to(base_url('Form_persetujuan'));
}
```

Fig. 7. View and Update Form

This function was created with the aim of being used by admins to change the form status, this form is the borrowing form that filled by the users if they want to borrow tools from the laboratory.

D. Testing

TABLE III. FUNCTIONALITY SUITABILITY TESTING RESULT

Laboratory Information System				
No	Testing Scenario	Test Data	Expected Result	Testing Result
1	Login Controller	Valid Data	Login Success	Login Success
		Invalid Data	Login Failed	Login Failed
2	Register Controller	Valid Data	Register Success	Register Success
		Invalid Data	Register Failed	Register Failed
3	Add Data on Tools table	Valid Data	Data Added successfully	Data Added successfully
		Invalid Data	Data Added Failed	Data Added Failed
4	Add Data on Document Table	Valid Data	Data Added successfully	Data Added successfully
		Invalid Data	Data Added Failed	Data Added Failed
5	Add Data on Laboratory Table	Valid Data	Data Added successfully	Data Added successfully
		Invalid Data	Data Added Failed	Data Added Failed
6	Add Data on Activity Table	Valid Data	Data Added successfully	Data Added successfully
		Invalid Data	Data Added Failed	Data Added Failed
7	Add Data on Form Table	Valid Data	Data Added successfully	Data Added successfully
		Invalid Data	Data Added Failed	Data Added Failed
8	Update Data on Form Table	Valid Data	Update Data Success	Update Data Success
		Invalid Data	Update Data Failed	Update Data Failed
9	Delete Data on Form Table	Valid Data	Data Deleted	Data Deleted
		Invalid Data	Failed To Delete Data	Failed To Delete Data
10	Change Password for admin	Valid Data	Update Data Success	Update Data Success
		Invalid Data	Update Data Failed	Update Data Failed
11	Add Data on Laboratorian Table	Valid Data	Data Added successfully	Data Added successfully
		Invalid Data	Data Added Failed	Data Added Failed
12	Search Data	Valid Data	Viewing the Filtered Data	Viewing the Filtered Data
		Invalid Data	Fail to View Data	Fail to View Data

First test was to determine Functionality Suitability of the system. This test was run using postman to check each function based on code of the program. Various test scenarios will be run using valid data and invalid data to see whether the program output will match the expected expectations. Following are the results of the Functionality Suitability test which show each function was running as expected. Performance Testing is a software testing process used for testing the speed, response time, stability, reliability, scalability, and resource usage of a software application under a particular workload to make sure whether an application has behaved satisfactory or not [12].

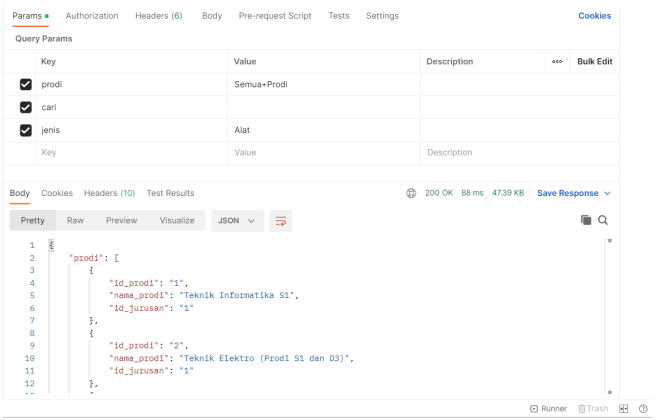

Fig. 8. Test Search Function without keyword

One of the most difficult features in this system is the search feature, this feature was tested using postman without using any keywords so that a lot of data needs to be displayed. The test results show that the loading speed of the data is very fast.

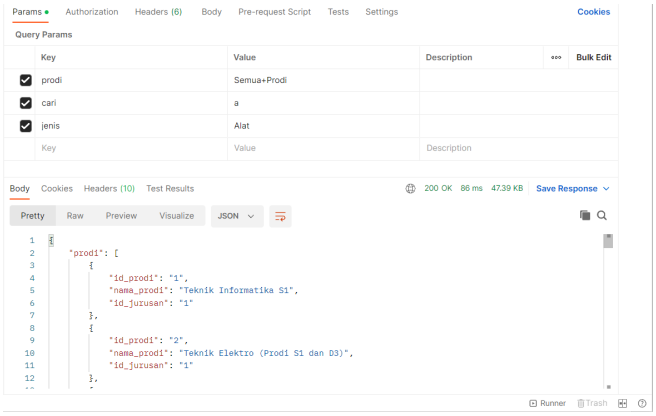

Fig. 9. Test Search Function with keyword

The photo above is a test carried out using keywords showing a loading time that is not much different compared to before.

Fig. 10. Performance Test Result Using WAPT

In addition, testing was also carried out using wapt on a system where 20 users constantly searched for data within 10 minutes. The results show that the response time is still relatively fast, namely an average of 0.85 seconds. Reliability, security, and maintainability test was tested using sonarqube. The result shows A Rating in all that category which shows that there is no critical error on the system.

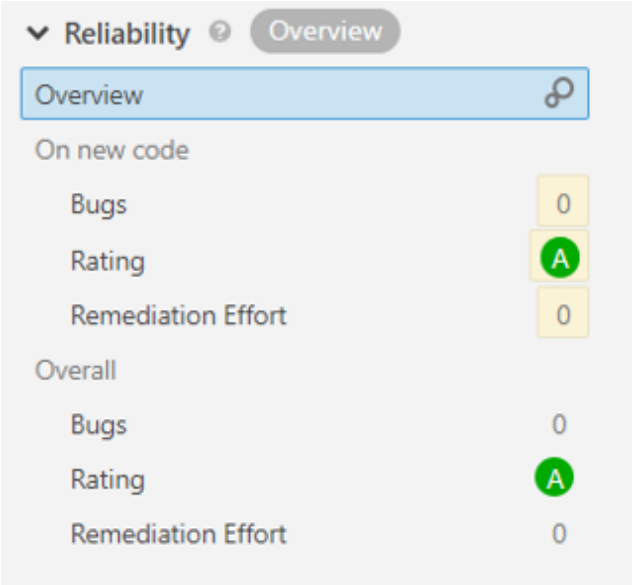

Fig. 11. Reliability Test

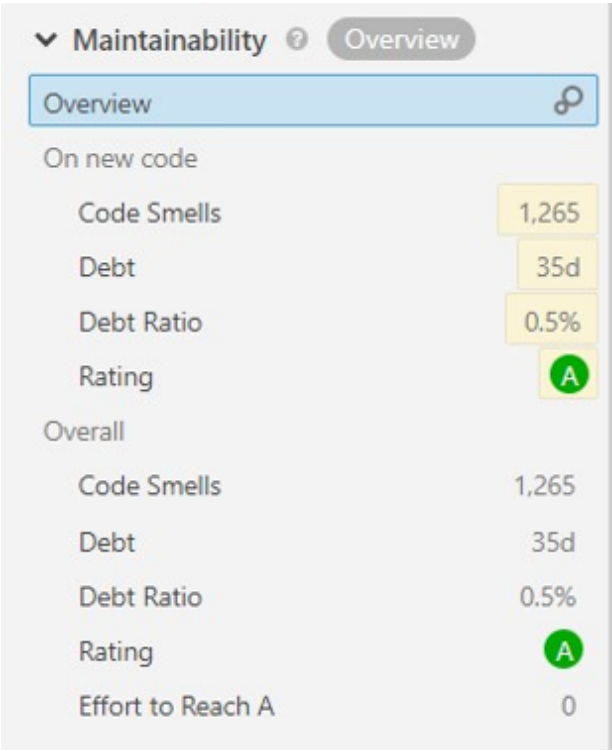

Fig. 12. Security Test

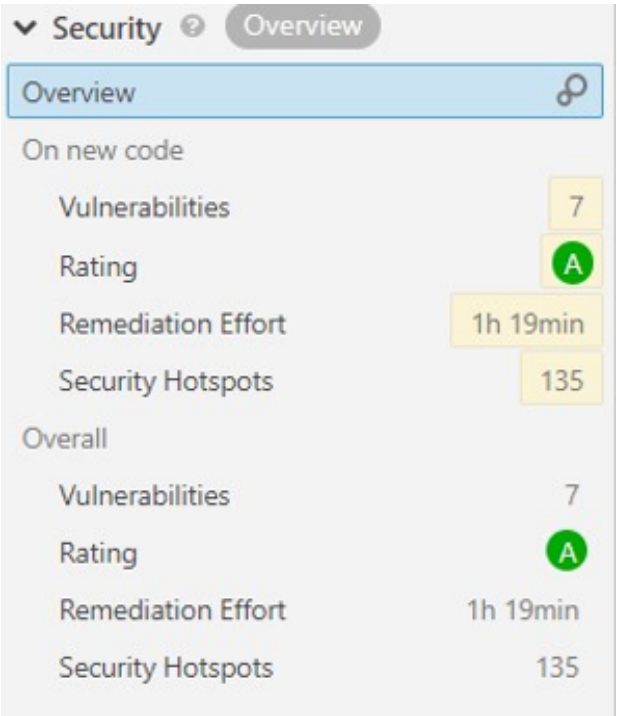

Fig.13. Maintainability Test

IV. Conclusion

The backend design of the laboratory information system at the Faculty of Engineering, Riau University is in accordance with the plan and is running as it should. the tests that were carried out also showed very good results and have shown that the system created is in accordance with the ISO 25010 that has been previously determined.

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