

# Evaluation of the Utilization of Web-based Library Application Information Systems using Whitebox and Blackbox Testing Methods

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**Abstract**—The library information system is a computerized process for integrated data management. This research was conducted in the library located at SMAN 12 Bandung, Jl. Sekejati No. 36, Sukapura. The importance of performance measurement. The validity of implementation from the perspective of effectiveness and efficiency of web-based libraries is the main thing in the aim of managing library digitalization. This research was carried out using the Whitebox and Blackbox Testing integration method. The purpose of the research is to conduct an Information Technology Audit with the validity of measuring the effectiveness and efficiency of application functions. The research results show that the technical analysis of FlowGraph Whitebox is based on source code and flowcharts running on Cyclomatic Complexity which counts the number of nodes and edges in FlowGraph. Research implications support the assessment of the concrete validity of the method used. This can be seen from the research results that the performance of the Web-based Widyantara Library application at SMAN 12 Bandung is considered satisfactory with a good level of validity, this is proven by the test results using the white box testing method. Meanwhile, based on the analysis of the black box testing method on application functionality, the test results are said to be good with a validity percentage reaching 100%. Validity according to application design is proven by testing 10 application scenarios.

**Index Terms**—Black box testing, digital library, system performance validity, SLiMS, white box testing.

## I. INTRODUCTION

A library is a system for managing various library materials such as books and recording media used for education, research, information storage, etc [1]. The library information system is a computerized process for managing data in libraries [2], [3]. According to [4] using the Library Information System at Sschool it can help librarians with time

shortages and increase the effectiveness of the performance of school library services. Currently, libraries are always integrated with SLiMS (Senayan Library Management System) which is an open source library automation system that provides efficient library management solutions [5], [6].

This research was conducted at the Widyantara Library which is located at SMAN 12 Bandung City, Jl. Sekejati No. 36, Sukapura, Kiaracondong. The problems that exist in the application system in this library are based on the results of field observations, there are functions that need to be improved, including data flow analysis, usability functions, and test automation in measuring the effectiveness and efficiency of application functions in accordance with the objectives of the research carried out. Therefore, it is necessary to analyze the Widyantara Computerized Library Information System at SMAN 12 Bandung to optimize the use of integrated information technology and provide convenience to school residents [7]. Based on previous research, implementing validity performance from the perspective of effectiveness and efficiency of web-based libraries has become the main thing in managing library digitalization [8]. The importance of this library application as a library media for the Academic Community of SMAN 12 Bandung in obtaining information, providing descriptions, and providing input in order to improve quality performance and have high validity for the application [9].

Based on the problems above and the integration of methods in previous research, the researcher took the technique of integrating white box and black box testing methods to find the validity point of measuring the effectiveness and efficiency of the Widyantara library application at SMAN 12 Bandung for all students in class X, XI and validity of the application's maximum performance. In assessing the use of information systems such as web-based library applications at SMAN 12 Bandung, the use of black box and white box testing methods is very effective because these two methods complement each other. Black box testing checks whether the system functions as expected from the user's perspective, while white box testing ensures that the internal structure of the code is efficient, secure,

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and error-free [10]. This approach provides a holistic view of the effectiveness and efficiency of the system, and helps in identifying and fixing problems from both the user and technical sides. Reference [11] proposed the integration of methods carried out in a study to determine the validity point of measuring the effectiveness and efficiency functions of library applications is necessary to find and achieve high validity results in managing integrated application systems.

Based on previous research regarding weaknesses in existing research using white box and black box testing methods, it shows the importance of a more holistic and comprehensive approach [12]. In this case, researchers attempt to combine these two methods to overcome the weaknesses of each and provide a more comprehensive evaluation of the information system. In the context of web-based library applications at SMAN 12 Bandung, the combined application of white box and black box testing is expected to provide more complete and reliable test results, ensuring that the system used not only functions well from the user's perspective but is also efficient, safe and free from internal errors [13]. Researchers have identified several problems and problem limitations resulting in several problem formulations as a research framework, including how to implement the use of the web-based Widyantara Library application information system. at SMAN 12 Bandung, and how is the evaluation of the use of information technology in optimizing Widyantara library services at SMAN 12 Bandung?

This research aims to illustrate the importance of evaluating and optimizing the system, especially in the context of school management and its relationship with the operational aspects of Widyantara Library services at SMAN 12 Bandung to obtain the maximum level of effectiveness and validity of the application. Apart from that, this research seeks to provide solutions and recommendations for improving the services provided by the Widyantara Library at SMAN 12 Bandung, by presenting steps that can be implemented by library staff at SMA Negeri 12 Bandung to increase the maximum effectiveness and validity of the application.

## II. RELATED WORK

According to [14] states that with the "White Box" method, applications or software are tested by examining modules and analyzing the program code created. In simple terms, "White Box" testing is carried out by looking directly at the source code of the application or software being tested, without paying attention to the appearance or user interface of the application.

Meanwhile, according to [15] the "Black Box" method is testing carried out based on application details such as appearance, functionality and functional flow in accordance with the needs of the designed operating system, without paying attention to the internals. details or application program code. This method is useful during application development, it can even be carried out during several phases in the life of a project and can be applied to unit testing, integration testing and system testing [16], [17].

In this research, the type of white box testing that will be applied is path testing. Path testing aims to examine all possible execution paths in an application to ensure that there are no logic errors that could cause malfunctions or undesired behavior [18]. This includes testing every branch condition and loop in the code, as well as data flow analysis to ensure that all variables are initialized and used correctly [19].

Meanwhile, the type of black box testing that will be used is functional testing. This functional testing aims to ensure that all the main features of the web-based library application at SMAN 12 Bandung function as expected. This includes testing the system's ability to perform book searches, borrowing, returns, and user account management [20]. This testing will be carried out by creating a series of test cases based on the system's functional specifications and checking whether the resulting output is as expected [21].

By combining black box and white box testing methods in this research, it can be ensured that the web-based library application at SMAN 12 Bandung not only functions according to user specifications, but also has a strong and safe internal structure [22]. This approach allows the identification and repair of problems from both functional and technical sides, resulting in a more reliable and high-quality system [23].

Based on the analysis and recommendations in previous research, the management of the Widyantara SMAN 12 Bandung library website requires detailed analysis to measure system code validation and application functionality using the white box and black box testing method [24], [25].

## III. RESEARCH METHOD

This research was carried out at SMAN 12 Bandung which is located on Jl. Sekejati No.36, Sukapura Village, Kiaracandong District, Bandung City, West Java Province. The aim of this research is to carry out an Information Technology Audit by evaluating bugs and errors in system code lines so as to optimize the use of integrated information technology and provide convenience to the academic community, especially librarians at SMAN 12 Bandung. The methods used in this research include collecting all school data and information in the form of documents and profiles of the Widyantara library at SMAN 12 Bandung, identifying problems related to operational optimization of the Widyantara Library web-based application at SMAN 12 Bandung, analyzing existing problems using the Whitebox testing technique and Black box testing, and evaluating the results of problem analysis to determine the necessary suggestions and recommendations. The description of the research method is depicted in Fig. 1.

In this research, black box testing will use instruments in the form of functional test cases, functional testing checklists, and bug reporting forms to ensure that all the main features of the web-based library application at SMAN 12 Bandung work as expected. This testing will be performed by researchers who are not involved in code development and have knowledge of the specifications and user requirements. Meanwhile, white box testing will use code analysis, test path analysis, test framework

analysis, as well as debugger and profiling analysis to examine execution paths, conditions and loops in the source code. This test will be carried out by researchers to understand the structure and implementation of the source code. Test results from both methods will be compiled, collaboratively analyzed, and retested after repair to ensure the application functions properly and has a strong internal structure. This approach aims to produce an objective and comprehensive evaluation, ensuring library applications not only meet user needs but are also of high quality internally.

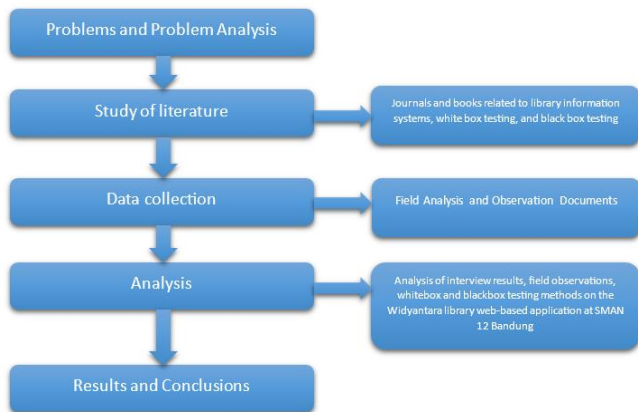


Fig. 1. Research framework.

The initial step in understanding the problem involves identifying problems that exist in the operational process of the Widyantara Library at SMAN 12 Bandung. After that, the author conducted a review of relevant literature to understand all variables, methods and research techniques related to the Widyantara Library web-based application at SMAN 12 Bandung. Next, the author collected data in the form of information and physical and non-physical documents based on the formulation and identification of problems in the application, as well as making direct observations in the field to understand the operational process of Widyantara Library services at SMAN 12 Bandung.

After the data was collected, the researcher analyzed the data and information using whitebox and blackbox testing techniques related to information and data obtained from field observations of the operational implementation of the Widyantara Library web-based application services at SMAN 12 Bandung.

#### IV. RESULT

At the discussion stage, researchers conducted direct observations and interviews regarding the implementation and implementation of the Widyantara Library web-based application at SMAN 12 Bandung. By conducting field observations and direct interviews, researchers obtained

various actual data and information related to operational services at the Widyantara Library at SMAN 12 Bandung, including work programs, library profiles, rules and standard operational procedures for the Widyantara library at SMAN 12 Bandung, both digitally and conventionally. After conducting observations and interviews, the researcher carried out a system analysis using the whitebox testing method and functional analysis of the application using the blackbox testing method.

#### A. Whitebox Testing

In white box testing, the first step is to compile flow graph notation based on the source code and flow diagram that is being run. Next, cyclomatic complexity is calculated by counting the number of nodes and edges based on the flow graph. The final step is to create test cases. The flow diagram of the Widyantaran library's web-based application system at SMAN 12 Bandung is analyzed from the source code and can be depicted in Fig. 2.

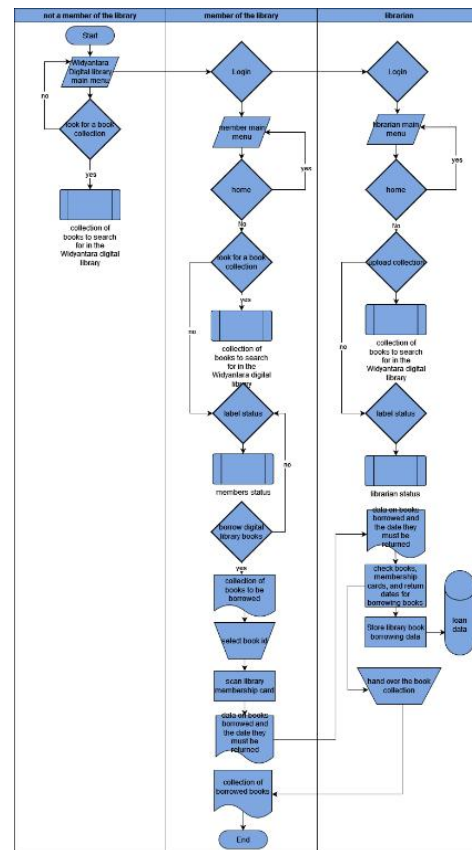


Fig. 2. Flowchart of the widyantara library web-based application system at SMAN 12 Bandung.

Figure 2 shows a flowchart of the Widyantara Library web-based application system at SMAN 12 Bandung regarding the circulation of borrowing and returning books, book collections, book registration for librarians. Next, based on the

flowchart above, it is converted into flowgraph notation in Fig. 3.

In Fig. 3, it can be concluded that there are 31 nodes and 33 edges in the Widyantara Library web-based application system at SMAN 12 Bandung. In the context of white box testing methods, circles of nodes are often used to represent the structure of program code. The numbers contained within these node circles usually refer to the complexity of the code path or the number of execution paths through that node. These numbers can provide information about how many execution paths should be tested to cover all branch and loop conditions in the source code. Nodes are a sequence of process and decision symbols, while edges are arrows depicted in the control flow according to the flow diagram.

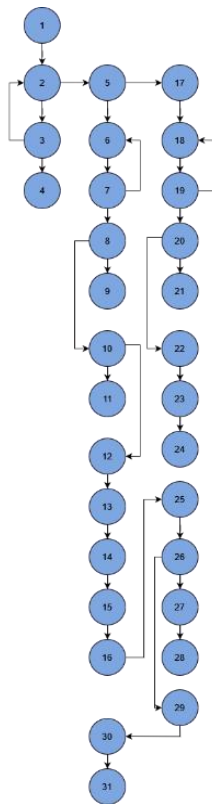


Fig. 3. Flowchart of the widyantara library web-based application system notation at SMAN 12 Bandung.

Based on Fig. 3, the cyclometric complexity can be calculated on the Widyantara Library web-based application system at SMAN 12 Bandung as follows:

$$V(G) = E - N + 2 \tag{1}$$

$$V(G) = 33 - 31 + 2 = 4$$

Based on the results of cyclometric complexity calculations on the Widyantara Library web-based application system at SMAN 12 Bandung, a maximum of 4 test cases or test cases are needed to test the effectiveness and efficiency of the flow or activities of the Widyantara Library web-based application system at SMAN 12 Bandung. From these calculations, the

overall  $V(G)$  is produced, if added together, there are 4 test case results that can be carried out, via independent paths as follows:

Path 1 : 1-2-3-4

Path 2 : 1-2-5-6-7-8-9

Path 3 : 1-2-5-6-7-8-10-12-13-14-15-16-25-26-27-28

Path 4 : 1-2-5-17-18-19-20-22-23-24

Based on the tests carried out, the researcher analyzed the input and output on the system which will be carried out as a test case on the Widyantara Library Web-Based Application System at SMAN 12 Bandung according to the flowchart and flowgraph which can be described in Tables 1 to 4.

Table 1.

Path 1 Searching for Book Collections Cyclometric Complexity Web Based Application System Widyantara Library SMAN 12 Bandung

Path Number	1 (Searching for Book Collections)
Path	1-2-3-4
Skenario	1. Start 2. Widyantara Digital library main menu 3. Look for a book collection 4. Collection of books to search for in the Widyantara digital library
Test result	Valid (Successful)

Table 2.

Path 2 Login Members Cyclometric Complexity Web Based Application System Widyantara Library SMAN 12 Bandung

Path Number	2 (Login Member)
Path	1-2-5-6-7-8-9
Skenario	1. Start 2. Widyantara Digital library main menu 3. Login 4. Member main menu 5. Home 6. Look for a book collection 7. Collection of books to search for in the Widyantara digital library
Test result	Valid (Successful)

Table 3.

Path 3 Storing Loan Data Cyclometric Complexity Web Based Application System Widyantara Library SMAN 12 Bandung

Path Number	3 (Storing Loan Data)
Path	1-2-5-6-7-8-10-12-13-14-15-16-25-26-27-28
Skenario	1. Start 2. Widyantara Digital library main menu 3. Login 4. Member main menu 5. Home 6. Look for a book collection 7. Label status 8. Borrow digital library books 9. Collection of books to be borrowed 10. Select book id 11. Scan library membership card 12. Data on books borrowed and the date they must be returned 13. Data on books borrowed and the date they must be returned 14. Check books, membership cards, and return dates for borrowing books 15. Store library book borrowing data 16. Loan data
Test result	Valid (Successful)

Table 4.

Path 4 Librarian Login Cyclometric Complexity Web Based Application System Widyantara Library SMAN 12 Bandung	
Path Number	4 (Librarian Login)
Path	: 1-2-5-17-18-19-20-22-23-24
Skenario	1. Start 2. Widyantara Digital library main menu 3. Login 4. Librarian Login 5. Librarian main menu 6. Home 7. Upload collection 8. Collection of books to search for in the Widyantara digital library 9. Label status 10. Librarian status
Test result	Valid (Successful)

Based on the information contained in Tables 1 to Table 4 above, it can be concluded that the performance of the Widyantara Library Web-based Application at SMAN 12 Bandung is considered satisfactory, as proven by the results of trials using the white box testing method which shows a good level of validity.

**B. Blackbox Testing**

In the software testing process using the Blackbox Testing technique, there are several stages of activities that need to be carried out. These stages are illustrated through the flow diagram in Fig. 4.

The scenario design stage involves designing the commands that will be executed on the form to be tested. The test case creation stage includes recording the columns to be tested on the input form. The test case testing stage involves executing tests by executing commands according to the designed test scenario. The test results reporting stage involves writing the entire test series in the form of a report along with details of the methods used in the test.

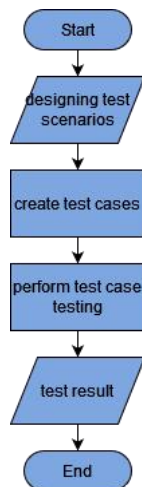


Fig. 4. Software testing flow diagram using the blackbox testing method.

In the analysis of software testing using the Blackbox Testing technique on the Widyantara Library web-based application at SMAN 12 Bandung, testing and analysis were carried out on the User Interface initialization login form, borrowing form, and return form for borrowed books.

The login page was tested because it is the first display that will be seen by users which can be seen in Figure 4 above. Therefore, its stability must be tested well before the application is introduced to the public. In this form, four types of input data will be tested as shown in Table 5.

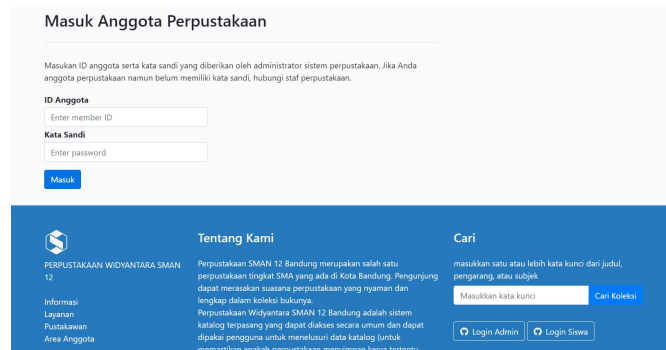


Fig. 5. Login form web based application system widyantara library SMAN 12 Bandung.

Table 5. Plan for Inputting Data on the Login Form Web-based Application System Widyantara Library SMAN 12 Bandung

ID	Test Description	Expected results
A01	Delete all filled data.	If the system detects that the username field is empty when attempting to log in, it will deny access and display a message stating that a username is required.
A02	Enter the username correctly but do not fill in the password field.	If the system finds that the password field is not filled in when attempting to log in, the system will deny access and display a message stating that the password must be filled in.
A03	Entering incorrect data into one of the fields.	The system will display a notification that the username or password entered is incorrect.
A04	Enter the appropriate data into the fields.	The system will receive login access and will direct you directly to the user's dashboard

The book borrowing form is one of the forms most frequently used by application users as seen in Fig. 6. This form has one field that must be filled in by the user, namely the book copy code. This form's test plan involves testing by entering four common variations of input data. The details are shown in Table 6.



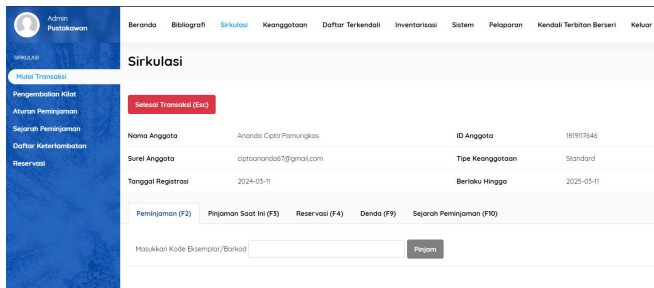


Fig. 6. Widyantara library web based application system book borrowing form at SMAN 12 Bandung.

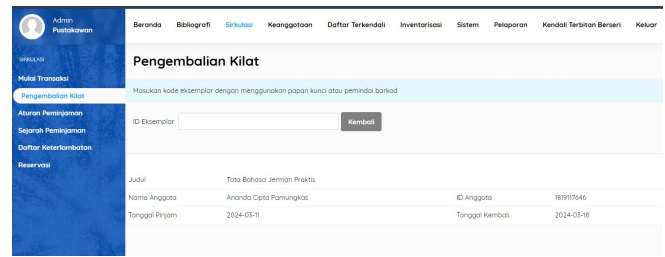


Fig. 8. Web-based widyantara library book express return application system at SMAN 12 Bandung.

Table 6.

Plan for Inputting Data on the Book Borrowing form for the Widyantara Library Web-based Application System at SMAN 12 Bandung

ID	Test Description	Expected results
B01	Not filling in or not entering data into the fields.	The system will issue an error message saying that the user has not entered the book to be borrowed.
B02	Entering a copy code that does not exist in the system database.	The system will provide an error message indicating that the user has incorrectly filled in copy code data that is not found in the system database.
B03	Enter the appropriate data into the fields.	The system will display a confirmation message that the book loan has been successful and automatically print proof of the loan.

Table 7.

Plan for Inputting Data on the Book Return form for the Widyantara Library Web-based Application System at SMAN 12 Bandung

ID	Test Description	Expected results
C01	Do not fill in or leave blank all data fields.	The system will display an error message indicating that the user has not entered the book to be returned.
C02	Entering a copy code that does not exist in the system database.	The system will provide an error message indicating that the user has incorrectly entered copy code data that is not found in the system database.
C03	Enter the appropriate data into the fields.	The system will display a success message that the book return has been successful and automatically print proof of return.

Returning books to the Widyantara Library web-based application system at SMAN 12 Bandung is done via a librarian account by clicking the "return" button on the application circulation menu which can be seen in Fig. 7.

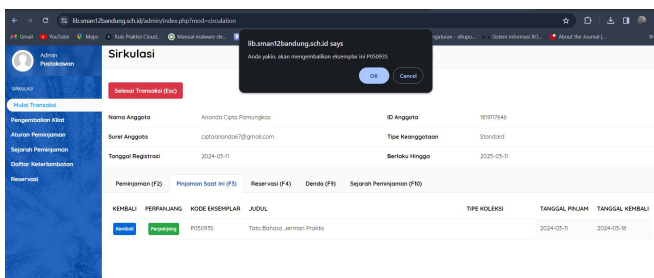


Fig. 7. Web-based widyantara library book return application system at SMAN 12 Bandung.

Table 8.

Results of Entering data on the Widyantara Library Web-based Application System Login form at SMAN 12 Bandung

ID	Test Description	Expected results	Test result	Conclusion
A01	Delete all filled data.	If the system detects that the username field is empty when attempting to log in, it will deny access and display a message stating that a username is required.	The system will display a message reminding you that the username field must be filled in before continuing.	valid or appropriate
A02	Enter the username correctly but do not fill in the password field.	If the system finds that the password field is not filled in when attempting to log in, the system will deny access and display a message stating that the password must be filled in.	The system will deny login access and provide a message that the password field must be filled in before the login process can continue.	valid or appropriate
A03	Entering incorrect data into one of the	The system will display a notification	The system will display a notification	valid or appropriate

The express book return form is one of the forms most frequently used by application users which can be seen in Fig. 8. This form has one field that must be filled in by the user, namely the book copy code. This form's test plan involves testing by entering four common variations of input data. The details are explained in Table 7. Based on the test results that have been carried out in accordance with the design in Table 5 – 7, the expected results are shown in relation to the test results with the previously prepared design, which can be seen in Table 8, 9, and 10.

	fields.	that the username or password entered is incorrect.	that the username or password entered is incorrect.	
A04	Enter the appropriate data into the fields.	The system will receive login access and will direct you directly to the user's dashboard	The system allows login access and automatically directs users to the dashboard page.	valid or appropriate

Table 9.

Result of Entering Data on the Book Borrowing form for the Widyantara Library Web-Based Application System at SMAN 12 Bandung

ID	Test Description	Expected results	Test result	Conclusion
B01	Not filling in or not entering data into the fields.	The system will issue an error message saying that the user has not entered the book to be borrowed.	The system will provide an error message stating that the user has not entered the book to be borrowed.	valid or appropriate
B02	Entering a copy code that does not exist in the system database.	The system will provide an error message indicating that the user has incorrectly filled in copy code data that is not found in the system database.	The system will provide an error message indicating that the user has incorrectly entered copy code data that does not exist in the system database.	valid or appropriate
B03	Enter the appropriate data into the fields.	The system will display a confirmation message that the book loan has been successful and automatically print proof of the loan.	The system will display a success message that the book loan was successful and automatically print proof of borrowing.	valid or appropriate

In Table 9, the results of data input for the book borrowing form on the Widyantara Library web-based application system at SMAN 12 Bandung from the blackbox testing method.

Table 10.

Result of Entering Data on the Book Return form for the Widyantara Library Web-based Application System at SMAN 12 Bandung

ID	Test Description	Expected results	Test result	Conclusion
C01	Do not fill in or leave blank all data fields.	The system will display an error message indicating that the user has not entered the book to be returned.	The system will provide an error message stating that the user has not entered the book to be returned.	valid or appropriate

C02	Entering a copy code that does not exist in the system database.	The system will provide an error message indicating that the user has incorrectly entered copy code data that is not found in the system database.	The system will provide an error message indicating that the user has incorrectly entered copy code data that does not exist in the system database.	valid or appropriate
C03	Enter the appropriate data into the fields.	The system will display a success message that the book return has been successful and automatically print proof of return.	The system will display a success message that the book return was successful and automatically print proof of return.	valid or appropriate

In Table 10, the proof borrowing documents on the web-based Widyantara library book lending application system at SMAN 12 Bandung from the blackbox testing method.

### C. Discussion

Based on the test results in this research, 10 test scenarios were carried out on various pages. Overall test results show satisfactory results. Based on these data, the following calculations are carried out:

$$\text{System Validity} = \frac{(JSK - JTSK)}{TSP} \times 100 \quad (2)$$

$$\text{System Validity} = \frac{(10 - 0)}{10} \times 100\%$$

JSK is a number of test scenarios, while JTSK is some unexpected scenario, and TSP is a total test scenario. The number 10 in system validity (2) represents the total number of test scenarios that have valid or matching test results in the table, according to the black box test technique. Meanwhile, the total amount of testing scenarios with invalid or inappropriate test results yields a value of 0 for the validity of the system.

### V. CONCLUSION

The whitebox testing method and the flow graph from the source code and the run flow diagram were used to show that counting the number of nodes and edges in the graph is how to figure out the cyclomatic complexity. The trials using the white box test method demonstrate a good level of validity, reinforcing this. These results suggest that the web-based Widyantara Library application at SMAN 12 Bandung functions adequately, and the white box method tests confirm its validity. Thus, this conclusion provides a solid picture of the quality and performance of the system, as well as providing confidence in the validity of the measurements carried out. In

addition, the blackbox testing method analysis of the application system's functionality yielded positive test results, demonstrating a 100% validity rate. This is in accordance with the application design, as proven by testing 10 scenarios on the application. Thus, this conclusion provides confidence that the Widyantara Library web-based application at SMAN 12 Bandung has functionality that is as expected.

Two test methods in this study provide a comprehensive overview of the quality and performance of the web-based Widyantara Library application at SMAN 12 Bandung. In terms of validity, the white box test results reinforce understanding of the internal structure of the code and the complexity of the application, while the black box tests confirm that the application function meets the user's expectations. Thus, the resulting integration of both methods gives a strong belief that the application not only has a strong technical foundation but is also able to meet the needs and expectations of users effectively.

In the future, improvements to the Widyantara Library web-based application at SMAN 12 Bandung involve further optimization of cyclic complexity through advanced testing techniques and functionality enhancements to maintain the current high level of validity and performance.

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