AUTOMATIC TESTING WITH BLACK BOX TESTING METHODS AND BOUNDARY VALUE ANALYSIS TECHNIQUES AT PT. HARTONO ISTANA TEKNOLOGI

[1]Andreas Edwin Kurniawan, [2]Rosita Herawati
[1,2]Program Studi Teknik Informatika Fakultas Ilmu Komputer,
Universitas Katolik Soegijapranata
[2]rosita@unika.ac.id

ABSTRACT

This study aims to direct the testing pattern from manual testing to automated testing. Another goal is that the use of manual methods is less effective, efficient, time consuming, expensive and allows for human testing errors. With automated testing, this problem can be solved. Before performing automated testing, must create a test case. Test cases are made using the Boundary Value Analysis (BVA) technique, the boundary value analysis technique is made by determining the upper and lower limits on a data. Automated testing using the selenium tool and the programming language used is python. After performing automated tests using the black box method, boundary value analysis technique, and selenium tools, we got the results. Testing is carried out on the company code menu, site, and location, testing is carried out as many as (180x). The results obtained after testing are kode perusahaan menu and nama perusahaan fields, the success rate is 50% fail and 50%. Next, in the kode perusahaan menu and nama perusahaan fields, the success rate is 25% fail and 75% success. Then, in the site menu and site fields, the success rate is 50% fail and 50% success. In the site menu and kode pos fields, the success rate is 25% fail and 75%. In the lokasi menu and tipe lokasi fields, the success rate is 25% fail and 75%. In the lokasi menu and kode fields, the success rate is 25% fail and 75% success.

Keywords: black box method, boundary value analysis technique, selenium tool, trial server ArtemisDev, python

INTRODUCTION

Along with the times, technology has become an alternative in solving various problems. One of the results of technological developments is the creation of many applications and software that help many people. The basis of application or software development is the creation of software that can keep up with the times according to user needs and produce software that can increase the effectiveness and efficiency of a company, industry and independent business. From this statement, it's necessary to measure software by testing to produce superior quality software. The purpose of testing is that the software does not contain errors or bugs that can interfere with the performance of the software.

There are two ways of testing that most people do, namely manual testing and automated testing. Testing manually is done by trying the menu, performance and overall features contained

in the software. The test requires a lot of resources and time, This is because testing is carried out continuously in the area to be tested so that no errors are found in the software. The author uses automated testing because manual testing has drawbacks, namely less effective and efficient, to support automated testing, the author uses a tool that is Selenium while those used in PT. Hartono Istana Teknologi is conducting manual testing. In testing the author also uses the black box method, black box method is a method that tests functionality, menus, and features without looking at the program. Meanwhile, before doing a test, the author makes a test case in order to find more errors in the software, The technique used in making test cases is Boundary Value Analysis (BVA). Boundary Value Analysis is a test technique that includes a representation of the limit value.

Based on this background and problems, so that software can run smoothly without finding errors or bugs, the author conducts research with the title "Automatic Testing With Black Box Testing Method And Boundary Value Analysis Techniques At PT. Hartono Istana Teknologi".

LITERATURE STUDY

Testing is an important component in the software development process. Various methods can be used in this phase. According to Nidhra and Dondeti [1], software testing is a broad field that mainly consists of various technical and non-technical areas such as requirements specification, maintenance, process, design and implementation, and management. Software testing is a commonly used method to confirm and ensure software quality. Traditionally, software testing techniques can be broadly classified into black-box testing and white-box testing. Black box testing or functional testing is a technique used to test the functionality of a system. It involves creating test cases that are designed based on the specifications provided. The other testing method called white box testing, which is also known as structural testing or glass box testing, test cases are designed based on information obtained from the source code.

The testing process is a verification process to assess the quality of software and ensure that the software fulfills the expected processes and directions. Boundary Value Analysis is one of the Black Box testing methods used to test sales applications. The Boundary Value Analysis method tests the maximum and minimum number of digits to produce a valid value. The application of the Black Box testing method with the Boundary Value Analysis technique on the sales application at PT Global Advindo Pratama produces quality software that is in accordance with its functions and can be utilized properly by users according to Yulistina et al.[2].

In software development, testing is an activity that takes up to 35% of the time, effort, or cost. To overcome this, what developers do is, do testing automatically. Automation testing is a technique that utilizes an application to carry out the complete software life cycle in a quicker and more effective manner, thus enhancing the efficiency of the testing process. The person testing the software application writes scripts and utilizes appropriate application software for the testing process. Automation testing is the process of using automation tools such as Selenium, Sikuli, Appium, etc., to create scripts for testing and run test cases. This allows for tests to be executed

with little to no manual intervention needed. Lathwal [3] concludes that automation testing using tools like Selenium and Sikuli can significantly reduce manual efforts and improve efficiency in software testing. However, both tools have their limitations, which can be overcome by using a hybrid test script (Selenium+Sikuli). This hybrid script can handle complex scenarios and is a powerful tool for automating almost all scenarios except for a few, such as Google captcha handling. The integration of Selenium with Sikuli is easy to implement and provides a new test framework with various good qualities from both automation tools.

The research conducted by Mostofa, K. and Fajar [4] is the same as the research conducted by the author, by using Selenium tools to perform functional testing automatically and get the result that multithreading in Ruby can speed up functional testing. Automation Testing is the automatic execution of test cases without manual intervention by simply recording and replaying which allows the tester to repeat the work in each test cycle. The purpose of using automated testing is so that further tests can run effectively and efficiently, according to Yutia when software becomes more complex it needs to be developed quickly. Therefore, automation testing is used to achieve effective, efficient, and lower costs [5]. The result of the test is that the implementation of the Tools Robot Framework in API testing has succeeded in producing test reports and test cases that run smoothly. An application may not be an error or bug. This is because developers rarely make mistakes, from the requirements-gathering stage to development. That's why software testing is necessary to detect and correct errors in software development, stated Verma et al. [6].

Mailewa et al. [7] discuss the significance of software programs trying out withinside the improvement of big software program systems. It explains that errors, or bugs, can arise at any degree of software program improvement and may reason full-size losses if now no longer diagnosed and eliminated early on. The article highlights that software program trying out is important to make sure that the software program is able to do what it became designed to do. They recognize that software programs trying out may be luxurious and time-consuming. It states that over 50% of the full fee of improvement is dedicated to software programs trying out. Therefore, the item explores methods to lessen trying out time and costs, consisting of decreasing the wide variety of check instances and automating repetitive trying out areas. Therefore, the use of automated testing is very important for software under development.

Jaya [8] conduct the testing phase of software used at Kantor Digital Politeknik Negeri Lampung. This testing is done using black box testing methods and Boundary Value Analysis techniques. The test results of the application can handle data in various circumstances with a success percentage of 91.67%. Testing with Boundary Value Analysis has a good search because it tests all available instructions or menus, This test is carried out with existing cases so that it can be seen the level of error that is owned by the information system being tested. The Blackbox Testing method offers several benefits: firstly, testers do not need to be familiar with a specific programming language; secondly, the testing is conducted based on the user's perspective, which aids in identifying any uncertainties or contradictions in the requirements specification; and thirdly, programmers and testers rely on each other in a mutually dependent manner. The

drawbacks of using the Blackbox Testing approach include the following: (1) It is challenging to create test cases without clear specifications; (2) There is a risk of redundant testing, where tests already performed by programmers are repeated; (3) Certain areas of the backend system remain untested.

The Black Box testing strategy encompasses various techniques, such as Equivalence Partitioning and Boundary Value Analysis. Equivalence Partitioning deals with input validation testing, focusing on three aspects: the validity of input classes, the examination of input content, and the accuracy of input. Boundary Value Analysis examines Black Box testing by considering the entire menu and module in order to identify potential errors. This finding was supported by Hidayat and Muttaqin [9] during their examination of the Online Graduation Registration and Payment Information System. The application of Black Box Testing to check the functionality of the software application and to observe the fundamental aspects of the software stated Sasmito and Nishom [10]. The use of the Boundary Value Analysis (BVA) technique in Black Box Testing to determine the lower and upper limit values based on the data being tested. The authors did the test at the population administration website using the Black Box Testing Boundary Value Analysis method to determine the lower and upper limit values based on the data being tested. The BVA test results showed that the application was able to handle data, both normal and abnormal, with a success percentage of 90.9%.

RESEARCH METHODOLOGY

Work Flow

The following is the research workflow carried out by the author explained with the steps carried out in this research

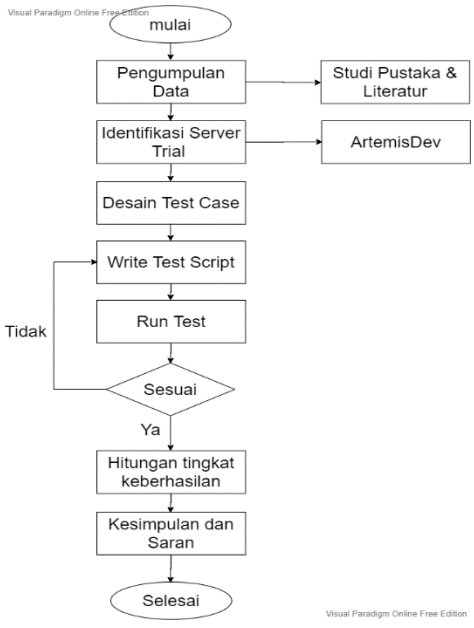

Figure 1. Work Flow Flowchart

Method Of Collecting Data

In conducting research, the author needs data or materials used to explain the research that the author makes. The appropriate data collection that the author made, will make research from the description of the results valid. The collection method used by the author is a literature study. A literature study is a method of collecting data by reading and studying research that has been done by others but has similarities with those made by the author. Data collection aims to be a source of author data and a reference for writers. The literature used by the author is a thesis, journals, and online books from within and outside the country.

Identification Server Trial

In this study, testing was carried out on a test PT. Hartono Istana Teknologi named ArtemisDev. ArtemisDev is a test server, there are many programs under development as well as newly created programs. The purpose of making ArtemisDev is so that before the program passes the Live stage, The program is tested first so that later there will be no errors or bugs in the program. On this test server, the author performs functional testing of the “kode perusahaan”, “site”, and “lokasi” menus.

Desain Test Case

In this study, the technique used by the author to design test cases is the Boundary Value Analysis (BVA) technique. In designing the test case, the author only tested functionally on certain menus on the ArtemisDev trial server. Boundary Value Analysis Technique is a test method that focuses on the upper and lower limit values.

Testing

In testing the author did it on the experimental server PT. Hartono Istana Teknologi. The menu that the author tested on the server was the kode perusahaan, site, and lokasi menu. The author performs functional testing by filling in the blanks and save according to test cases generated and run automatically. From the test automatically obtained the results will then get the percentage of test success. How to calculate the percentage of success is the number of successful data divided by the total number of data, then the success rate will be obtained.

ANALYSIS AND DESIGN

Analysis

The method used in this research is the Black Box method. The Black Box method is a testing method that only tests the functionality and usability of the application or web, Black Box Testing only checks input and output on an application/web as expected or without knowing the program. Automation Testing works by comparing the desired output with the resulting output. To produce this output, most people use scripts or test tools to generate the output. PT. Hartono Istana Teknologi still uses manual testing in doing the test because the company has not been able to find what kind of method can be used to be effective and efficient in conducting testing. Test Case is a

flow or series of what will be done by the user (user in this sense is Quality Assurance). At PT. Hartono Istana Teknologi in working on a project makes use cases based on requests from users. The purpose of the Test Case is to ensure an application or web can run properly as desired and can provide feedback on incorrect input on the application or web. Selenium is a tool used for Automation Testing. This tool is used to perform automated tests on a multi-platform web, which means it can run on multiple platforms. There are 4 types of selenium, namely Selenium IDE, WebDriver, Selenium Remote Control (RC), and Selenium Grid.Selenium WebDriver. Selenium WebDriver is an open source, this tool can also be run in various languages including Java, Python, Ruby, #C, etc and can be used in various browsers including Mozilla Firefox, Chrome, Opera, Safari, and Internet Explorer, etc. It is also a multi-system operating tool, which means it can support multiple operating systems including Linux, Windows and Mac.

Table Test Case

Button Functionality Testing "Tambah Kode Perusahaan"

Field testing kode perusahaan, the data type used is varchar but which will include a 6 letter character set. In the "kode perusahaan" column, the author adds testing by trying various test variables, namely the number of characters is more than 6, the number of characters is less than 6, the number of characters according to the provisions is 6 and the column is empty. . By doing this test the author can find out whether the field is in accordance with the provisions or not. If there are no errors, the field can be declared according to company regulations.

Table 1. Kode Perusahaan Field Trial Scenario

No	Scenario	Results
1	Number of characters more than 6	Can be input
2	Number of characters less than 6	Can be input
3	The number of characters according to the provisions is 6	Can be input
4	Empty	Error message

Field testing kode pos, the data type used is varchar, but will enter a 10 character string namely numbers. In the kode pos column, the author adds testing by trying various test variables,

namely the number of characters is more than 10, the number of characters is less than 10, the number of characters according to the provisions is 10 and the column is empty. By doing this test the author can find out whether the field is in accordance with the provisions or not. If there are no errors, the field can be declared according to company regulations.

Table 2. Kode Field Trial Scenario

No	Scenario	Result
1	Number of characters more than 10	Can be input
2	Number of characters less than 10	Can be input
3	The number of characters according to the provisions is 10	Can be input
4	Empty	Error message

Button Functionality Testing "Tambah Lokasi"

Field testing site, the data type used is varchar but which will include a 15 letter character set. In the "site" column, the author adds testing by trying various test variables, namely the number of characters is more than 15, the number of characters is less than 15, the number of characters according to the provisions is 15 and the column is empty. By doing this test the author can find out whether the field is in accordance with the provisions or not. If there are no errors, the field can be declared according to company regulations.

Table 3. Site Field Trial Scenario

No	Scenario	Result
1	Number of characters more than 15	Can be input
2	Number of characters less than 15	Can be input
3	The number of characters according to the provisions is 15	Can be input
4	Empty	Error message

Field testing kode pos, the data type used is varchar, but will enter a 10 character string namely numbers. In the kode pos column, the author adds testing by trying various test variables, namely the number of characters is more than 10, the number of characters is less than 10, the number of characters according to the provisions is 10 and the column is empty. By doing this test the author can find out whether the field is in accordance with the provisions or not. If there are no errors, the field can be declared according to company regulations.

Table 4. Kode Field Trial Scenario

No	Scenario	Result
1	Number of characters more than 10	Can be input
2	Number of characters less than 10	Can be input
3	The number of characters according to the provisions is 10	Can be input
4	Empty	Error message

Button Functionality Testing "Tambah Lokasi"

Field testing Tipe Lokasi, the data type used is varchar but which will include a 25 letter character set. In the tipe lokasi column, the author adds testing by trying various test variables, namely the number of characters is more than 25, the number of characters is less than 25, the number of characters according to the provisions is 25 and the column is empty. By doing this

test the author can find out whether the field is in accordance with the provisions or not. If there are no errors, the field can be declared according to company regulations.

Table 5. Tipe Lokasi Field Trial Scenario

No	Scenario	Result
1	Number of characters more than 25	Can be input
2	Number of characters less than 25	Can be input
3	The number of characters according to the provisions is 25	Can be input
4	Empty	Error message

Field testing kode, the data type used is varchar, but will enter a 15 character string namely numbers. In the kode column, the author adds testing by trying various test variables, namely the number of characters is more than 15, the number of characters is less than 15, the number of characters according to the provisions is 15 and the column is empty. By doing this test the author can find out whether the field is in accordance with the provisions or not. If there are no errors, the field can be declared according to company regulations.

Table 6. Kode Field Trial Scenario

No	Skenario	Hasil
1	Number of characters more than 15	Can be input
2	Number of characters less than 15	Can be input
3	The number of characters according to the provisions is 15	Can be input
4	Empty	Error message

IMPLEMENTATION AND RESULT

Implementation

In this study, the first test was carried out on the kode perusahaan menu program kodeperusahaan.py, second test was carried out on site menu program site.py, and last test was carried out on lokasi menu program lokasi.py. These programs are tested automatically using Selenium and the Python programming language. One of the commands used to run the three

programs is to click the desired button and fill in the empty fields with the data that has been created in Microsoft Excel and exit the program. By checking the test web and writing code according to the created concept, the test can automatically run properly.

Testing

The test conducted by the author was carried out with five times (5x) different experiments and four scenarios, namely (1) the number of characters less, (2) the number of characters, (3) the number of characters according to the provisions, and (4) empty. This test program is run for ± 40 seconds, before running the program the computer must be connected to a VPN connected to the server PT. Hartono Istana Teknologi. The data was entered on the test server PT. Hartono Istana Teknologi is dummy data used for testing.

Button Functionality Testing Tambah Kode Perusahaan

Field testing kode perusahaan, the data type used is varchar but it will include a 6 letter character set. Test results in the kode perusahaan field by specifying the lower and upper limits, in the scenario of the number of characters more than 6, the number of characters according to the provisions is 6 with failed results and the number of characters is less than 6, empty with successful results. The result can be seen in Table 7.

Table 7. Kode Perusahaan Field Test Result

No	Scenario	Result	Successful Rate
1	Number of characters more than 6	Can be input	0%
2	Number of characters less than 6	Can be input	100%
3	The number of characters according to the provisions is 6	Can be input	0%
4	Empty	Error message	100%

Field testing nama perusahaan, the data type used is varchar, but will enter a 50 character string including alphabet, numbers, and spaces. Test results in the nama perusahaan field by specifying the lower and upper limits, in the scenario of the number of characters more than 50 with failed results and the number of characters less than 50, the number of characters according to the provisions is 50 and emptied with a successful result. The result can be seen in Table 8.

Table 8. Nama Perusahaan Field Test Result

No	Scenario	Result	Successful Rate
1	Number of characters more than 50	Can be input	0%
2	Number of characters less than 50	Can be input	100%
3	The number of characters according to the provisions is 50	Can be input	100%
4	Empty	Error message	100%

Button Functionality Testing Tambah Site

Field testing site, the data type used is varchar but which will include a 15 letter character set. Test results in the site field by specifying the lower and upper limits, in the scenario of the number of characters more than 15, the number of characters according to the provisions is 15 with failed results and the number of characters is less than 15, empty with successful results.

Table 9. Site Field Test Results

No	Scenario	Result	Successful Rate
1	Number of characters more than 15	Can be input	0%
2	Number of characters less than 15	Can be input	100%
3	The number of characters according to the provisions is 15	Can be input	0%
4	Empty	Error message	100%

Field testing kode pos, the data type used is varchar, but will enter a 10 character string namely numbers. Test results in the kode pos field by specifying the lower and upper limits, in the scenario of the number of characters more than 10 with failed results and the number of characters less than 10, the number of characters according to the provisions is 10 and emptied with a successful result.

Table 10. Kode Pos Field Test Results

No	Scenario	Result	Successful Rate
1	Number of characters more than 10	Can be input	0%
2	Number of characters less than 10	Can be input	100%
3	The number of characters according to the provisions is 10	Can be input	100%
4	Empty	Error message	100%

Button Functionality Testing Tambah Site

Field Testing Tipe Lokasi, the data type used is varchar but which will include a 25 letter character set. Test results in the site field by specifying the lower and upper limits, in the scenario of the number of characters more than 25, the number of characters according to the provisions is 25 with failed results and the number of characters is less than 25, empty with successful results.

Table 11. Tipe Lokasi Field Test Results

No	Scenario	Result	Successful Rate
1	Number of characters more than 25	Can be input	0%
2	Number of characters less than 25	Can be input	100%
3	The number of characters according to the provisions is 25	Can be input	100%
4	Empty	Error message	100%

Field Testing Kode, the data type used is varchar, but will enter a 15 characters string including alphabet, numbers, and spaces. Test results in the code field by specifying the lower and upper limits, in the scenario of the number of characters more than 15 with failed results and the number of characters less than 15, the number of characters according to the provisions is 15, and emptied with a successful result.

Table 12. Kode Field Test Result

No	Scenario	Result	Successful Rate
1	Number of characters more than 15	Can be input	0%
2	Number of characters less than 15	Can be input	100%
3	The number of characters according to the provisions is 15	Can be input	100%
4	Empty	Error message	100%

Results

The results of research conducted by the author, the success rate for each field contained in the kode perusahaan, site, and lokasi menus is calculated manually. In the kode perusahaan menu and nama perusahaan fields, the success rate is 50% fail and 50% success is made from 4 predefined lower and upper bounds and five different attempts (20x), 40 total tests in 1 test case. Next, in the kode perusahaan menu and nama perusahaan fields, the success rate is 25% fail and 75% success from 4 predefined lower and upper limits and five different attempts (20x) attempts, 40 total tests in 1 test case. Then, in the site menu and site fields, the success rate is 50% fail and 50% success is made from 4 predefined lower and upper bounds and five different attempts (20x), 40 total tests in 1 test case. In the site menu and kode pos fields, the success rate is 25% fail and 75% success from 4 predefined lower and upper limits and five different attempts (20x) attempts, 40 total tests in 1 test case. In the lokasi menu and tipe lokasi fields, the success rate is 25% fail and 75% success from 4 predefined lower and upper limits and five different attempts (20x) attempts, 40 total tests in 1 test case. In the lokasi menu and kode fields, the success rate is 25% fail and 75% success from 4 predefined lower and upper limits and five different attempts (20x) attempts, 40 total tests in 1 test case. Total of (180x) tests carried out by the author. Next, a diagram will be presented to explain the results obtained from the research conducted by the author.

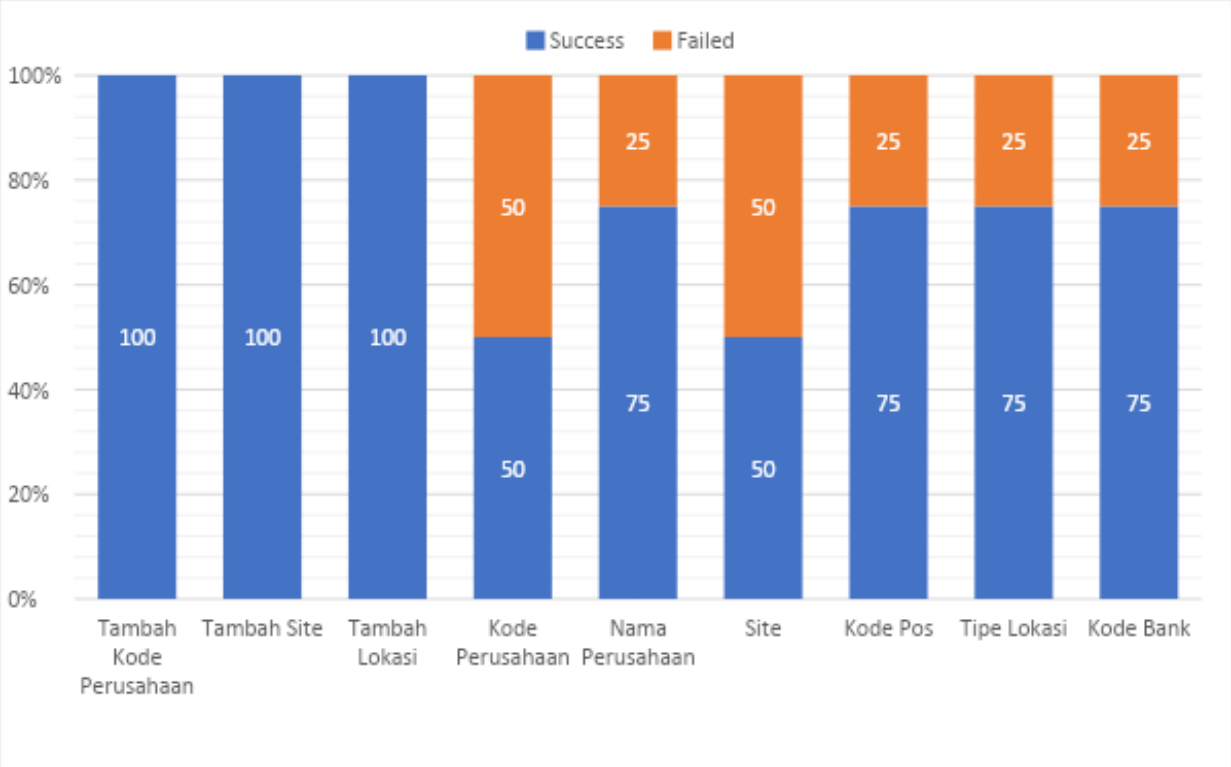

Figure 2. Diagram Success Rate Of Each Test Case (%)

Binary Classification Metric

Button Functionality Testing Tambah Kode Perusahaan

Table 13. Performance Measurement of button tambah kode perusahaan

Test Scenario	Recall	Precision	Accuracy	F1-Score
Button "Tambah Kode Perusahaan"	1	1	1	1
Field "Kode Perusahaan"	1	0.5	0.5	0.67
Field "Menu Perusahaan"	1	0.75	0.75	0.857

In Testing Button Functionality "Tambah Kode Perusahaan", 4 types of tests were carried out by determining the upper and lower limits. The results show that all test predictions were correct by the score of 1 across multiple measurements as shown in Table 13. For other scenarios, the results are not as good as a button "Tambah Kode Perusahaan" especially for Field "Kode Perusahaan" where only 50% of the predicted are correct.

Button Functionality Testing Tambah Site

Table 14. Performance Measurement of button "Tambah Site"

Test Scenario	Recall	Precision	Accuracy	F1-Score
Button "Tambah Site"	1	1	1	1
Field "Site"	1	0.5	0.5	0.67
Field "Kode Pos"	1	0.5	0.5	0.67

In Testing Button Functionality "Tambah Site", 4 types of tests were carried out by determining the upper and lower limits. The results show that all test predictions were all correct by the score of 1 across multiple measurements as shown in Table 14. On the other hand, only half are predicted correctly

Button Functionality Testing Tambah Lokasi

Table 15. Performance Measurement of button "Tambah Lokasi"

Test Scenario	Recall	Precision	Accuracy	F1-Score
Button "Tambah Site"	1	1	1	1
Field "Site"	1	0.75	0.75	0.857
Field "Kode Pos"	1	0.75	0.75	0.857

In Testing Button Functionality "Tambah Lokasi", 4 types of tests were carried out by determining the upper and lower limits. The results show that all test predictions were correct by the score of 1 across multiple measurements as shown in Table 15. On the other hand, only 75% are predicted correctly.

CONCLUSION

After automated testing on the ArtemisDev Trial Server using the black-box method, boundary value analysis techniques, and selenium tools, it can be concluded that, the black-box method is a suitable method for testing because the author performs functional testing on the ArtemisDev trial server, kode perusahaan, site, and lokasi menu. Next, for making test cases using boundary value analysis techniques by determining the lower and upper limits on data. The tool used for testing on the ArtemisDev test server is the Selenium tool. Selenium is used to perform automated testing and is suitable to be applied in this research. The reason for using the selenium tool in this research is that it is open source, supports various programming languages, is flexible, and supports various platforms. Testing on ArtemisDev conducted by PT. Hartono Istana Teknologi is based on a concept that has been created by the company so that testing can be carried out in stages, structured and the main purpose of testing can be achieved.

Based on the conclusions above, the authors provide suggestions for further research in order to develop, For further testing it is recommended to use the white box testing method. White box testing, namely testing software/applications by analyzing the program code whether there is something wrong or not. It is hoped that testing can be carried out on different menus and buttons to reduce the risk of data similarity in a study. The software testing tool changed to Katalon Studio, to compare Selenium and Katalon Studio usage. Comparison in terms of performance and effectiveness.

REFERENCES

[1] S. Nidhra, "Black Box and White Box Testing Techniques - A Literature Review," *Int. J. Embed. Syst. Appl.*, vol. 2, no. 2, hlm. 29–50, Jun 2012, doi: 10.5121/ijesa.2012.2204.

[2] S. R. Yulistina, T. Nurmala, R. M. A. T. Supriawan, S. H. I. Juni, dan A. Saifudin, "Penerapan Teknik Boundary Value Analysis untuk Pengujian Aplikasi Penjualan Menggunakan Metode Black Box Testing," *J. Inform. Univ. Pamulang*, vol. 5, no. 2, hlm. 129, Jun 2020, doi: 10.32493/informatika.v5i2.5366.

[3] A. Lathwal, "A Literature Review on Automation Testing Using Selenium+Sikuli:," *Int. J. Distrib. Artif. Intell.*, vol. 11, no. 2, hlm. 35–40, Jul 2019, doi: 10.4018/IJDAI.2019070104.

[4] K. Mustofa dan S. Fajar, "Selenium-Based Multithreading Functional Testing," *IJCCS Indones. J. Comput. Cybern. Syst.*, vol. 12, hlm. 63, Jan 2018, doi: 10.22146/ijccs.28121.

[5] S. N. Yutia, "Automated Functional Testing pada API menggunakan Keyword Driven Framework," *J. Inform. Commun. Technol. JICT*, vol. 3, no. 1, hlm. 65–78, Jul 2021, doi: 10.52661/j_ict.v3i1.70.

[6] A. Verma, A. Khatana, dan S. Chaudhary, "A Comparative Study of Black Box Testing and White Box Testing," *Int. J. Comput. Sci. Eng.*, vol. 5, hlm. 301–304, Des 2017, doi: 10.26438/ijcse/v5i12.301304.

[7] A. B. Mailewa, "A Survey of Effective and Efficient Software Testing," dalam *ProceedingsMICS_2015*, North Dakota: University of North Dakota, 2015. [Daring]. Tersedia pada: https://www.researchgate.net/publication/322343314_A_Survey_of_Effective_and_Efficient_Software_Testing

[8] T. S. Jaya, "Pengujian aplikasi dengan metode blackbox testing boundary value analysis (studi kasus: kantor digital Politeknik Negeri Lampung)," *J. Inform. J. Pengemb. IT*, vol. 3, no. 1, hlm. 45–48, 2018.

[9] T. N. Hidayat dan M. I. Muttaqin, "Pengujian Sistem Informasi Pendaftaran dan Pembayaran Wisuda Online menggunakan Black Box Testing dengan Metode Equivalence Partitioning dan Boundary Value Analysis," dalam *Jutis (Jurnal Teknik Informatika) 2018*, dalam 1, vol. 6. 2018, hlm. 38. [Daring]. Tersedia pada: https://api.semanticscholar.org/CorpusID:212885919

[10] G. W. Sasmito dan M. Nishom, "Testing the Population Administration Website Application Using the Black Box Testing Boundary Value Analysis Method," dalam *2020 IEEE Conference on Open Systems (ICOS)*, Kota Kinabalu, Malaysia: IEEE, Nov 2020, hlm. 48–52. doi: 10.1109/ICOS50156.2020.9293645.