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Black Box Testing of the "Hybrid Engine" Application Using Boundary Value Analysis Technique

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Abstract: The "Hybrid Engine" application is an introduction to a hybrid engine that is packaged attractively and can be accessed online, this application is very important for conveying information about hybrid engines, if an error occurs in the functional application there can be misunderstandings about the information conveyed. Therefore it is necessary to test to ensure the quality of the application that has been produced. Testing is an evaluation process of assessing the functional quality of software to check whether the software meets the expected process or not. Functional processes that have not been maximized can cause inequalities in the data information to be displayed. Applications that have been designed must go through the testing stages to ensure the level of functional quality. Of the several types of black box testing methods, one of them is Boundary Value Analysis. The method tests the maximum and minimum number of digits to produce a valid value and is easy enough to test "hybrid engine" applications. The first stage carried out in this research is to identify the functionality to be processed and ensure that the maximum and minimum number of digits matches the predetermined system arrangement. The result of applying the method used is that the quality of the application is under its function, and can be utilized properly by the user. The results of the Boundary Value Analysis test show that the application is following the expected system and instructions with a success percentage of 78.245615%.
Keywords: Black box testing; Boundary value analysis technique; Hybrid Engine application; Hybrid Machine; Testing application

INTRODUCTION

With its enormous diversity, computer technology has become a necessary component of many kinds of human endeavors. In less than two decades, the Internet and computer software has expanded to become the biggest knowledge reservoir in human history. [1] Multimedia applications, which are media that can communicate information in a better, more visible, and more intuitive way, are one example of how computer technology is used in the world today.[2] A computer platform called the Hybrid Engine application houses data on hybrid engines. Information on the history of hybrid engines, their components, operating techniques, and integration into vehicles may all be found in this application. This program is accessible online and may be used on any device, including smartphones, tablets, laptops, desktop computers, and other devices running IOS, Android, Windows, and other operating systems. This hybrid engine integrates content in the form of videos, images, photographs, text, and other formats into a single application. To grab the user's attention, this Hybrid Engine application is presented aesthetically, simply, and effectively. Because it contains all the instructions

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and information from hybrid machines, this application is crucial for users or employees who deal with hybrid equipment. A common engine used in modern automobiles is the hybrid engine. [3]

The stages of the Research and development method—potential issues, data gathering, analysis, design, product validation, and a number of black box and white box tests—are used in the Hybrid Engine application design process using the Figma software. Finding problems is the goal of the potential and problems stage, which is followed by the analysis stage, which involves analyzing the problems to be solved, the design process, which involves creating the Hybrid Engine application and validating the final product, and the testing stage, which includes both black box and white box testing. [4]

Application testing is necessary to determine whether or not the application performs as intended. [5] Testing is a series of deliberate, methodical actions intended to verify or assess the desired truth. [6] The test activity is made up of one or more stages that might set up the design of certain test cases. Maintaining customer happiness and software quality is necessary since they are crucial for international marketing. In order to increase the quality of the program, you must choose the appropriate testing technique—specifically, one that can uncover flaws that have not yet been identified. [7]

The Black Box method with the Boundary Value Analysis technique is the approach suggested for evaluating the quality of this application. The design is tested using black box testing. The goal of testing is to ascertain whether the software's features, input, and output adhere to the necessary requirements. The only way to test is to run or execute units or models both offline and online in front of the general public, then check to see if the outcomes match the desired procedure. [8]

The data to be tested is based on values that are close to both valid and invalid limits when using the Black Box method and the Boundary Value Analysis approach. [9] The maximum and minimum number of digits to be examined are determined using the Boundary Value Analysis approach. [10] This program can be tested in a number of stages using the suggested test methodology. The stages or strategies for carrying out this test include building test cases and figuring out the maximum and lowest amount of digits for each column through a number of specified stages. The goal of this test is to make sure that users can effectively use the Hybrid Engine application in accordance with its intended use..

METHOD

Black Box Testing, which tries to demonstrate the PL function's functionality, determine whether the output data entry has performed as anticipated, and determine whether the externally stored information is always maintained current [11]. A software testing method that focuses on the functional requirements of the software is another way to understand black-box testing [12]. Software engineers can perform "black box testing" to obtain a set of input conditions that fully utilize all of a program's functional requirements. [13]

Black box testing is a complementary strategy to the white box technique since it is anticipated to disclose a larger variety of problems than the white box technique. In order to create a set of input conditions that exactly match a program's functional needs, black box testing focuses on the functional testing requirements of software. Black box testing examines the core functions of the system without taking into account the software's internal logical architecture. This approach is used to check the software's functionality. [19] Black Box testing is a technique for designing data tests that is based on software requirements. Data from the software's completion test are used to determine whether the output is as expected. The following sorts of mistakes are sought for by this Black Box test:

1. Wrong or absent functions.
2. A faulty interface.
3. Access to an external database or data structure error.
4. A performance mistake.
5. Problems in initialization and termination

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The following are the phases of testing:

a. The technique of evaluating individual software elements, such as methods or object classes, is known as unit testing. The simplest kind of component is one with a single function or method [14]. The goal of this testing phase is to validate the smallest pieces (software modules/components).

b. Integration Testing is a methodical approach for developing software architecture while carrying out tests to find interface-related issues. The objective is to create a program structure that is defined by design using unit-tested components. The focus of integration testing is mostly on evaluating how well the software's component components work together. Pressman advises staged integration testing to prevent difficulties tracking in the event of an issue [15].

c. System testing examines the compatibility, functionality, and timely data flow of components across their interfaces [14]. System testing is used to ensure that system components have been correctly integrated and are carrying out their assigned functions [15].

Black Box Testing is one of the testing techniques described in terms of the software's functionality [16]. The functional program description's input requirements and operational procedures are summarized in this exam. Black Box Testing is used to find a variety of issues, including functional, interface, data structure, function, declaration, and termination defects [17]. Equivalence Partitioning, Boundary Value Analysis, Robustness Testing, Behavior Testing, and Cause-Effect Relationship Testing are some of the approaches used in testing utilizing Blackbox. [18] Using the just-explained methodology, boundary value analysis is used to assess the "hybrid engine" application. The value must be opened/dissected, then grouped into recognizable bounds, as this is the procedure used to test the value entered into the system. Each set includes values that each component expects to handle in a similar manner. Consider both valid and invalid partitions when creating test cases.

Boundary Value Analysis is a technique used in Black Box Testing that focuses on the maximum and least number of values submitted in the application. A generic way to apply BVA is to make sure that other variable agreements are included together with the maximum value for one variable and that it has a nominal value (determined by average or nominal values). Minimum, Minimum + 1, Average, Maximum-1, and Maximum are the values used to analyze the data [9]. The limit will be determined by entering the code in the following example with the Alphanumeric declaration:

$$\mathbf{0 \leq number \leq 9 \text{ and } A \leq letter \leq Z}$$

There are numerous stages that can be completed in this research, starting with problem identification, followed by test data selection, testing using the boundary value analysis technique, entering test data into the system, calculating test data, and finally recording the results. test [9]. Figures 1 show the research process and the evaluated form.

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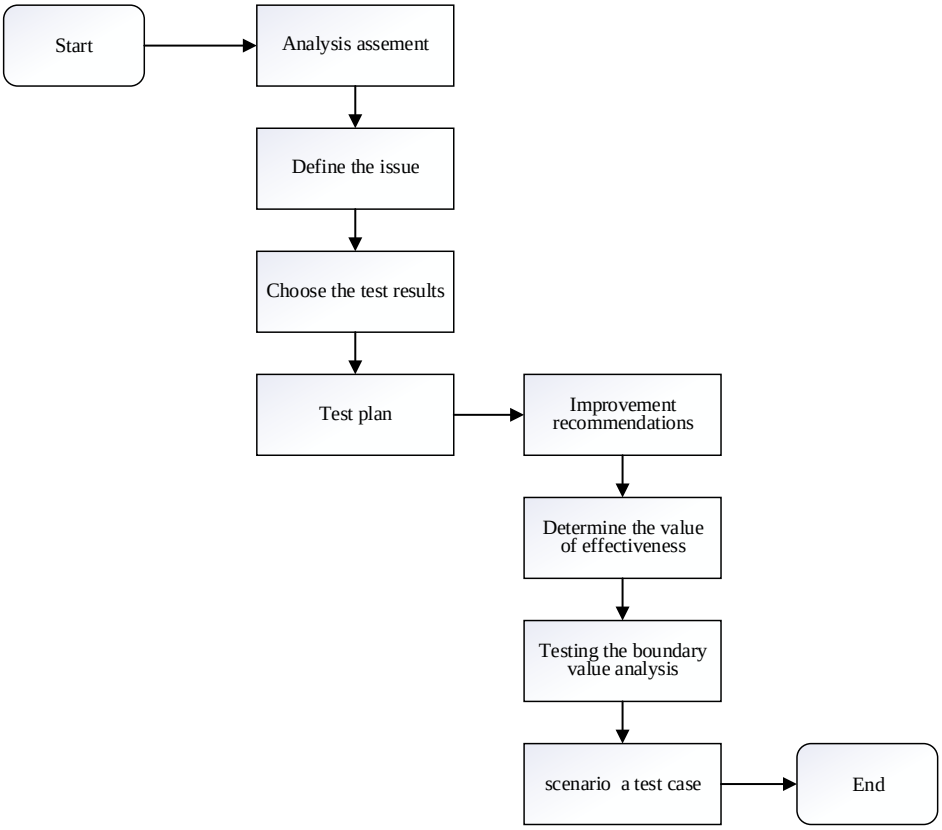

Figure 1. Research Stage

The testers require the research flow in order for the testing to proceed in an organized manner. Starting a test requires the tester to choose the methods and procedures that will be applied. Here, testing is conducted utilizing the Boundary Value Analysis approach and the Black Box testing method. The identification of current issues is the second stage. In this case, faulty application validation is the issue to be examined. The test data are chosen in the third stage. Stock data will be used for the test data, and the data will be connected to current issues. The fourth and fifth stages prepare data for Black Box testing based on the Boundary Value Analysis technique, which will result in a solution for the current issue.

The test results are calculated in the sixth stage using the percentage created throughout the test, followed by test reporting documentation.

To ensure that the tests are run in the correct order, the tester might utilize the test flow as a guide when executing a test. A requirements analysis of the company is conducted before testing to ascertain the purpose of the "Hybrid Engine" application. Define the test data that will be used during testing after which you should determine whether there are any existing problems. After obtaining the test data, the tester selects the test data or test plan, including the test procedure. The next step is to create a test scenario in line with the selected testing approach and execute a Black Box Boundary Value Analysis test. The tester then assesses the effectiveness of the application in light of the test results and offers recommendations for improvement to the application developer.

1. Analysis Assignment

The needs analysis process itself is a tool or strategy for locating issues and choosing the best course of action or remedy. The authors spoke with firm employees in order to assess the demands of the business. The purpose of the interview is to learn more about the firm, the system that will be tested, and any research requirements.

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2. Define the issue
The "hybrid Engine" application's functioning is the issue here that needs to be tested. The "Hybrid Engine" application's functionality will be evaluated to determine whether it meets user needs and whether it is functioning effectively.

3. Choose the test results.
Meaning of test data or research data is all facts and figures that can be used as raw material to create information. The feedback data from the offered buttons were used in this test, and the data is strongly tied to the functionality of the application.

4. Test Plan
The test plan itself is a document that details all of the testing goals and procedures. Function testing, business cycle testing, user interface testing, security testing, and access control testing should all be employed in this situation.

5. Scenario a test case.
Software testing activities known as test scenarios use fictitious story scenarios to guide testers through the solution of challenging problems or test systems.

Table 1: User scenarios in using “Hybrid Engine” Application

ID	Construct a test case	Test Case	Expected results
HE 1	Starting the “Hybrid Engine” application	Click the “Start Learning” button	Page switches to “About Hybrid Engine” and then
HE 2	Users can change the language to English or Indonesian	Click the British / Indonesian flag	The page text content changes from Indonesian to English or vice versa.
HE 3	User input name, class, and Department	Input name: Citra, Class: E-1A, and Department: Electrical	Spelling will appear such as the Citra, E-1A, and department that is filled in and will be stored in the database and will be displayed on the next screen.
HE 4	The user opens the "Definitions About Hybrid Engine" page	Click the “Get started” button	The "Definitions About Hybrid Engine" page switched.
HE 5	The user has finished reading	Click the "Finish Read" button	switch the “Congratulations!” page switched.
HE 6	The user continues to explore the application	Click the "Explore next" button	“The History of Hybrid Engine” page switched.
HE 7	The user opens the “History of Hybrid Engine”	Click the “Get started” button	The “History of Hybrid Engine” page switched.
HE 8	The user has finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 9	The user continues to explore the application	Click the "Explore next" button	“Inventors of Hybrid Engine” page switched.
HE 10	The user opens the “Inventors of Hybrid Engine” page	Pressing the “Get started” button	“Inventors of Hybrid Engine” page switched.
HE 11	The user has finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.

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HE 12	The user continues to explore the application	Click the "Explore next" button	“Strength and Weakness” page switched.
HE 13	The user opens the “ Strength and Weakness” page	Click the “Strength and Weakness” button	“Strength and Weakness” page switched.
HE 14	The user opens the ”1. Saved Fuel” page	Click the “Learn More” button	“Saved Fuel” page switched.
HE 15	The user has finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 16	The user continues to explore the application	Click the "Explore next" button	“Increased Acceleration & Speed” page switched.
HE 17	The user opens the “ “Increased Acceleration & Speed” page	Click the “Learn More” button	“Increased Acceleration & Speed” page switched.
HE 18	The user have finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 19	The user continues to explore the application	Click the "Explore next" button	“Environmentally Friendly” page switched.
HE 20	The user opens the “ “Environmentally Friendly” page	Click the “Learn More” button	“Environmentally Friendly” page switched.
HE 21	User have been finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 22	The user continues to explore the application	Click the "Explore next" button	“Smoother Engine Vibration” page switched.
HE 23	User opens the “ Smoother Engine Vibration” page	Click the “Learn More” button	“Smoother Engine Vibration” page switched.
HE 24	The user have finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 25	The user continues to explore the application	Click the "Explore next" button	“Smoother Gear Shift” page switched.
HE 26	User opens the “ Smoother Gear Shift” page	Click the “Learn More” button	“Smoother Gear Shift” page switched.
HE 27	The user have finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 28	The user continues to explore the application	Click the "Explore next" button	“Types of Hybrid Engine” page switched.
HE 29	The user opens the “ Types of Hybrid Engine” page	Click the “ Types of Hybrid Engine”	“Types of Hybrid Engine” page switched.
HE 30	The user opens the menu page “ Both Series and Parallel Hybrid / full Time Hybrid”	Click the “Learn More” button	“Series Hybrid /PHEV plugin hybrid electric vehicle” page switched.

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HE 31	The user has finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 32	The user continues to explore the application	Click the "Explore next" button	“Parallel Hybrid / assist Motor” page switched.
HE 33	The user opens the “ Parallel Hybrid / Assist Motor” page	Click the “Learn More” button	“Parallel Hybrid / assist Motor” page switched.
HE 34	The user have finished reading	Click The “ Finish Read” button	“Congratulations!” page switched
HE 35	The user continues to explore the application	Click the "Explore next" button	“Both Series and Parallel Hybrid / Full Time Hybrid” page switched.
HE 36	The user opens the “Both Series and Parallel Hybrid / Full Time Hybrid” page	Click the “Learn More” button	“Both Series and Parallel Hybrid / Full Time Hybrid” page switched.
HE 37	The user have finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 38	The user continues to explore the application	Click the "Explore next" button	“Hybrid Engine Components” page switched.
HE 39	The user opens “Hybrid Engine Components” page	Click the “ The Components”	“Hybrid Engine Components” page switched.
HE 40	The user opens “Internal Combustion Engine” page	Click the “Learn More” button	“Internal Combustion Engine” page switched.
HE 41	The user has finished reading	Click The “ Finish Read” button	“Congratulations!”page switched.
HE 42	The user continues to explore the application	Click the "Explore next" button	“ Electric Motor” page switched.
HE 43	The user opens the “Electric Motor” page	Click the “Learn More” button	T “ Electric Motor” page switched.
HE 44	The user has finished reading	Click The “ Finish Read” button	“Congratulations!” page switched.
HE 45	The user continues to explore the application	Click the "Explore next" button	“ Generator” page switched.
HE 46	The user opens the “Electric Motor” page	Click the “Learn More” button	“ Generator” page switched.
HE 47	Users have finished reading	Click The “ Finish Read” button	“Congratulations! page switched.
HE 48	The user continues to explore the application	Click the "Explore next" button	“Power Split Device” page switched.
HE 49	The user opens the “Power Split Device” page	Click the “Learn More” button	“Power Split Device” page switched.
HE 50	The user has finished reading	Click The “ Finish Read” button	“Congratulations! page switched.
HE 51	The user continues to explore the application	Click the "Explore next" button	“Power Control Unit” page switched.
HE 52	The user opens the “Power Control Unit” page	Click the “Learn More” button	“Power Control Unit” page switched.
HE 53	The user has finished reading	Click The “ Finish Read” button	“Congratulations! page switched.

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He 54	The user continues to explore the application	Click the "Explore next" button	“Battery” page switched.
HE 55	The user opens the “Battery” page	Click the “Learn More” button	“Battery” page switched.
HE 56	The user has finished reading	Click The “ Finish Read” button	“Congratulations! page switched.
HE 57	End-user	Click The “ Finish” button	Back to the home button.

Table 1 is an example of a test scenario in research In this table, there are 57 test scenarios accompanied by tests case and expected results. In this test, there is 1 table to be tested. Table 2 is an example of a test scenario in research In this table, there are 5 test scenarios accompanied by tests case and expected results. In this test, there is 2 table to be tested.

Table 2: User scenarios in input name, class and department

ID	Construct a test case	Test Case	Expected results
HE 001	User fills in name with Citra, class with 2 and department with Electrical	Name : Citra Class: 2 Department: Electrical	The spelling "Citra" appears in the name column, "2" appears in the class column and "Electrical" in the Department column and is stored in databases
HE 002	The user fills in the name with C1tr4, class with 2, and Department and Department with Electrical	Name : C1tr4 Class : 2 Department: Electrical	The spelling "C1tr4" appears in the name column, "2" appears in the class column and "Electrical" in the Department column and is stored in databases
HE 003	The user fills in the name with C1tr4, class with 2, and Department and department with Electrical	Name: C1tr4 Class: dua Department: Electrical	The spelling "C1tr4" appears in the name column, "Dua" appears in the class column and "Electrical" in the Department column and is stored in databases
HE 004	The user fills in the name with C1tr4, class with dua and Department with electrical 1	Name: Citra Class: 2 Department: Electrical 1	The spelling "C1tr4" appears in the name column, "Dua" appears in the class column and "Electrical 1" in the Department column and is stored in databases
HE 005	User fills in name with Citra Dewi, class with 2 and major with Electrical one	Name : Citra Dewi Class : 2 Department: Electrical one	The spelling "Citra Dewi" appears in the name column, "2" appears in the class column and "Electrical one" in the Department column and is stored in databases

6. Testing the boundary value analysis

After creating the test scenario, the black box boundary value analysis is tested. Based on the created test cases, this test is executed.

7. Determine the value of effectiveness

The proportion of system feasibility produces the effectiveness value itself. The "Hybrid Engine" application's performance can be gauged using the effectiveness value.

$$\left(\frac{\Sigma\, appropriate\ result}{\Sigma\, testing\ results}\right) x100$$

Figure 2 , The formula for determining each table's effectiveness value

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The formula for determining each table's effectiveness value is shown in Figure 2. Each table has a number of test situations, each with its own conclusion. Calculate all of the relevant conclusions in a table, divide by the total number of test scenarios in the table, then multiply by 100 to get the effectiveness value for each table.

$$\left(\frac{(value\ ef\ Table\ A + value\ ef\ table\ B + \cdots . value\ Table\ n)}{\Sigma\ number\ of\ tables\ tested}\right)$$

Figure 3 The method used to determine the value of overall effectiveness

The formula for determining the total effectiveness value is shown in Figure 3 You must first know the effectiveness value of each table in order to calculate the total effectiveness value. Adding up all the effectiveness numbers for each table and dividing by the total number of examined tables yields the overall effectiveness value. The value of the application's efficacy is the outcome of this calculation.

8. Improvement recommendations

The final part of this research is to provide the developer with final recommendations for enhancements. Applications with faults still need urgent recommendations for improvements. The "hybrid engine" application's errors will be seen as a call for improvement.

RESULT

At this stage, the results of testing the "Hybrid Engine" application will be discussed, consisting of the results of test scenarios, effectiveness scores, list of system weaknesses and recommendations for improvement.

Test results

The outcomes of the test scenarios are the outcomes of application testing that was done in line with the created test scenarios. This table seeks to determine whether or not the output's findings match those anticipated.

Table 2. Scenario Results Testing the application "Hybrid Engine"

ID	Scenario a test case	Expected results	Test Result	Conclusion
HE 1	Starting the “Hybrid Engine” application	Page switches to “About Hybrid Engine” and then	Page switches to “About Hybrid Engine” then	Consistent
HE 2	Users can change the language to English or Indonesian	The page text content changes from Indonesian to English or vice versa.	The page text content changes from Indonesian to English or vice versa.	Consistent
HE 3	User input name, class, and Department	Spelling will appear such as the Citra, E-1A, and department that is filled in and will be stored in the database and will be displayed on the next screen.	Spelling will appear such as the Citra, E-1A, and department that is filled in and will be stored in the database and will be displayed on the next screen.	Consistent

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HE 4	The user opens the "Definitions About Hybrid Engine" page	"Definitions About Hybrid Engine" page switched.	"Definitions About Hybrid Engine" page switched.	Consistent
HE 5	The user have finished reading	switch “Congratulations!” page switched.	switch “Congratulations!” page switched.	Consistent
HE 6	The user continues to explore the application	“Hystory of Hybrid Engine” page switched.	“Hystory of Hybrid Engine” page switched.	Consistent
HE 7	The user opens the “Hystory of Hybrid Engine”	“Hystory of Hybrid Engine” page switched.	“Hystory of Hybrid Engine” page switched.	Consistent
HE 8	The user have finished reading	“Congratulations!” page switched.	“Congratulations!” page switched.	Consistent
HE 9	The user continues to explore the application	“Inventors of Hybrid Engine” page switched.	Page “Inventors of Hybrid Engine” can not be switched.	Dissonant
HE 10	The user opens the “Inventors of Hybrid Engine” page	“Inventors of Hybrid Engine” page switched.	“Inventors of Hybrid Engine” page switched.	Consistent
HE 11	The user have finished reading	“Congratulations!” page switched.	“Congratulations!” page switched.	Consistent
HE 12	The user continues to explore the application	“Strength and Weakness” page switched.	“Strength and Weakness” page switched.	Consistent
HE 13	The user opens the “ Strength and Weakness” page	“Strength and Weakness” page switched.	“Strength and Weakness” page switched.	Consistent
HE 14	The user opens the ”1. Saved Fuel” page	“Saved Fuel” page switched.	“Saved Fuel” page switched.	Consistent
HE 15	The user have finished reading	“Congratulations!” page switched.	“Congratulations!” page switched.	Consistent
HE 16	The user continues to explore the application	“Increased Acceleration & Speed” page switched.	“Increased Acceleration & Speed” page switched.	Consistent
HE 17	The user opens the “ “Increased Acceleration & Speed” page	“Increased Acceleration & Speed” page switched.	“Increased Acceleration & Speed” page switched.	Consistent
HE 18	The user have finished reading	“Congratulations!” page switched.	“Congratulations!” page switched.	Consistent
HE 19	The user continues to explore the application	“Environmentally Friendly” page switched.	“Environmentally Friendly” page switched.	Consistent
HE 20	User opens the “ “Environmentally Friendly” page	“Environmentally Friendly” page switched.	“Environmentally Friendly” page switched.	Users

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HE 21	Users have been finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 22	The user continues to explore the application	"Smoother Engine Vibration" page switched.	"Smoother Engine Vibration" page switched.	Consistent
HE 23	User opens the " Smoother Engine Vibration" page	"Smoother Engine Vibration" page switched.	"Smoother Engine Vibration" page switched.	Consistent
HE 24	The user have finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 25	The user continues to explore the application	"Smoother Gear Shift" page switched.	"Smoother Gear Shift" page switched.	Consistent
HE 26	User opens the " Smoother Gear Shift" page	"Smoother Gear Shift" page switched.	"Smoother Gear Shift" page switched.	Consistent
HE 27	The user have finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 28	The user continues to explore the application	"Types of Hybrid Engine" page switched.	"Types of Hybrid Engine" page switched.	Consistent
HE 29	The user opens the " Types of Hybrid Engine" page	"Types of Hybrid Engine" page switched.	"Types of Hybrid Engine" page switched.	Consistent
HE 30	User opens the menu page " Both Series and Parallel Hybrid / full Time Hybrid"	"Series Hybrid /PHEV plugin hybrid electri vehicle" page switched.	"Series Hybrid /PHEV plugin hybrid electri vehicle" page switched.	Consistent
HE 31	The user have finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 32	The user continues to explore the application	"Parallel Hybrid / assist Motor" page switched.	"Parallel Hybrid / assist Motor" page switched.	Consistent
HE 33	The user opens the " Paralel Hybrid / Assist Motor" page	"Parallel Hybrid / assist Motor" page switched.	"Parallel Hybrid / assist Motor" page switched.	Consistent
HE 34	The user have finished reading	"Congratulations!" page switched	"Congratulations!" page switched	Consistent
HE 35	The user continues to explore the application	"Both Series and Parallel Hybrid / Full Time Hybrid" page switched.	"Both Series and Parallel Hybrid / Full Time Hybrid" page switched.	Consistent
HE 36	The user opens the "Both Series and Parallel Hybrid / Full Time Hybrid" page	"Both Series and Parallel Hybrid /	"Both Series and Parallel Hybrid /	Consistent

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		Full Time Hybrid" page switched.	Full Time Hybrid" page switched.	
HE 37	The user have finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 38	The user continues to explore the application	"Hybrid Engine Components" page switched.	"Hybrid Engine Components" page switched.	Consistent
HE 39	The user opens "Hybrid Engine Components" page	"Hybrid Engine Components" page switched.	"Hybrid Engine Components" page switched.	Consistent
HE 40	The user opens "Internal Combustion Engine" page	"Internal Combustion Engine" page switched.	"Internal Combustion Engine" page switched.	Consistent
HE 41	The user have finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 42	User continues to explore the application	" Electric Motor" page switched.	" Electric Motor" page switched.	Consistent
HE 43	The user opens the "Electric Motor" page	T " Electric Motor" page switched.	T " Electric Motor" page switched.	Consistent
HE 44	The user have finished reading	"Congratulations!" page switched.	"Congratulations!" page switched.	Consistent
HE 45	The user continues to explore the application	" Generator" page switched.	" Generator" page switched.	Consistent
HE 46	User opens the "Electric Motor" page	" Generator" page switched.	" Generator" page switched.	Consistent
HE 47	Users have been finished reading	"Congratulations! page switched.	"Congratulations! page switched.	Consistent
HE 48	The user continues to explore the application	"Power Split Device" page switched.	"Power Split Device" page switched.	Consistent
HE 49	The user opens the "Power Split Device" page	"Power Split Device" page switched.	"Power Split Device" page switched.	Consistent
HE 50	The user have finished reading	"Congratulations! page switched.	"Congratulations! page switched.	Consistent
HE 51	The user continues to explore the application	"Power Control Unit" page switched.	"Power Control Unit" page switched.	Consistent
HE 52	The user opens the "Power Control Unit" page	"Power Control Unit" page switched.	"Power Control Unit" page switched.	Consistent
HE 53	The user have finished reading	"Congratulations! page switched.	"Congratulations! page switched.	Consistent
He 54	The user continues to explore the application	"Battery" page switched.	"Battery" page switched.	Consistent
HE 55	The user opens the "Battery" page	"Battery" page switched.	"Battery" page switched.	Dissonant
HE 56	The user have finished reading	"Congratulations! page switched.	"Congratulations! page switched.	Consistent
HE 57	End-user	Back to home's button.	Back to home's button.	Consistent

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Table 3 and table 4 is an example of the results of the tested scenarios carried out, after obtaining the appropriate or inappropriate conclusions. The next step namely determining the value of effectiveness based on the results of the test scenario.

Table 4 Test results input name, class and department

ID	Scenario a test case	Expected results	Test Result	Conclusion
HE 001	User fills in name with Citra, class with 2, and department with Electrical	The spelling "Citra" appears in the name column, "2" appears in the class column and "Electrical" in the Department column and is stored in databases	Spelling according to the nominal transaction and transactions can be saved or printed	Consistent
HE 002	The user fills in the name with C1tr4, class with 2, and Department and Department with Electrical	The spelling "C1tr4" appears in the name column, "2" appears in the class column and "Electrical" in the Department column and is stored in databases	The system does not recognize this variable and the entry cannot be saved and the system refuses.	Dissonant
HE 003	The user fills in the name with C1tr4, class with 2 and Department and Department with Electrical	The spelling "C1tr4" appears in the name column, "Dua" appears in the class column and "Electrical" in the Department column and is stored in databases	The system does not recognize this variable and the entry cannot be saved and the system refuses.	Dissonant
HE 004	The user fills in the name with C1tr4, class with two and Department with Department with electrical 1	The spelling "C1tr4" appears in the name column, "Dua" appears in the class column and "Electrical 1" in the Department column and is stored in databases	The system does not recognize this variable and the entry cannot be saved and the system refuses.	Dissonant
HE 005	User fills in name with Citra Dewi, class with 2 and major with Electrical one	The spelling "Citra Dewi" appears in the name column, "2" appears in the class column and "Electrical one" in the Department column and is stored in databases	Spelling according to the nominal transaction and transactions can be saved or printed	Consistent

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Effectiveness Value

The number of tested tables, the number of test scenarios, and the outcomes of the test scenarios must be known to determine an application's effectiveness.

Table 3. Conclusion table of test data results

Conclusion table of test data results	
Information	Amount
The table that was tested	2 table
Test scenario	62 test scenarios
Consistent conclusion	57 consistent conclusion
Dissonant conclusion	5 Dissonant conclusion

Table 3 shows the conclusion of the results of the overall test data in that test has been done. After knowing the test results, the following is the result of calculating the value effectiveness of each table:

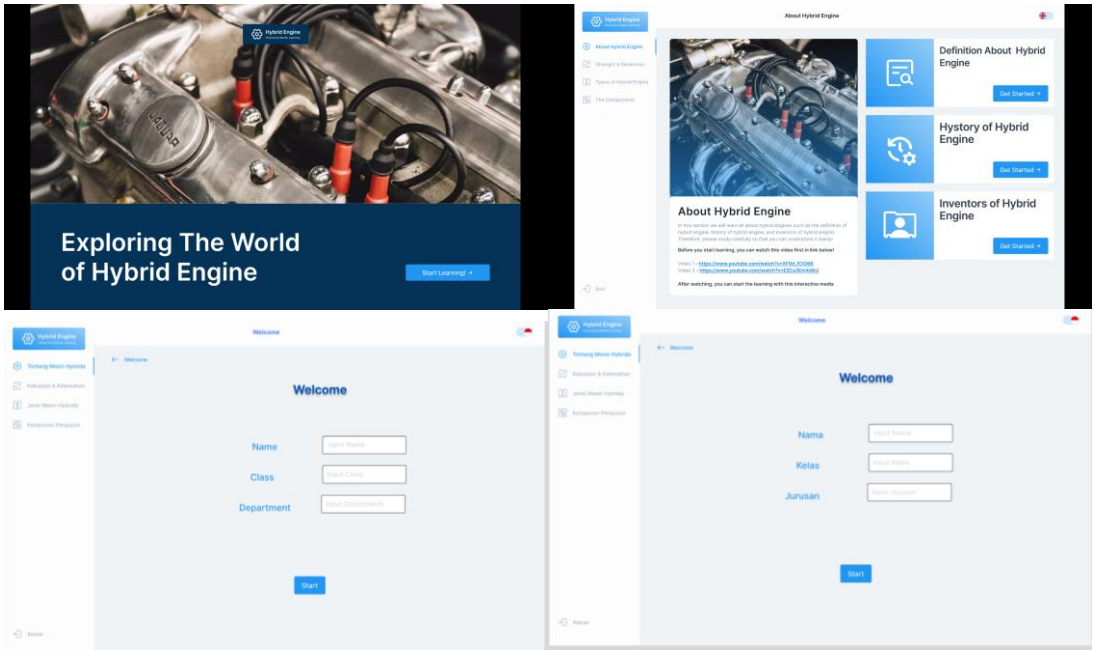
$$\text{Table 1} : \left(\frac{55}{57}\right) \text{ x } 100\% = 96.49123\%$$

$$\text{Table 2} : \left(\frac{3}{5}\right) \text{ x } 100\% = 60\%$$

After calculating the effectiveness value of each table, it can be continued calculate the overall effectiveness value, by adding up all the results of the value the effectiveness of each table and divided by the number of tables tested:

$$\left(\frac{96.49123+60}{2}\right) \text{ x } 100\% = 78.245615\%$$

The effectiveness value of the "hybrid engine" application is 78.245615%. With this value, The "hybrid engine" application is already running according to the specified functionality expected but there are still some bugs in the app which should be fixed soon updated. Figure 5 shows some views of the "hybrid engine" application.



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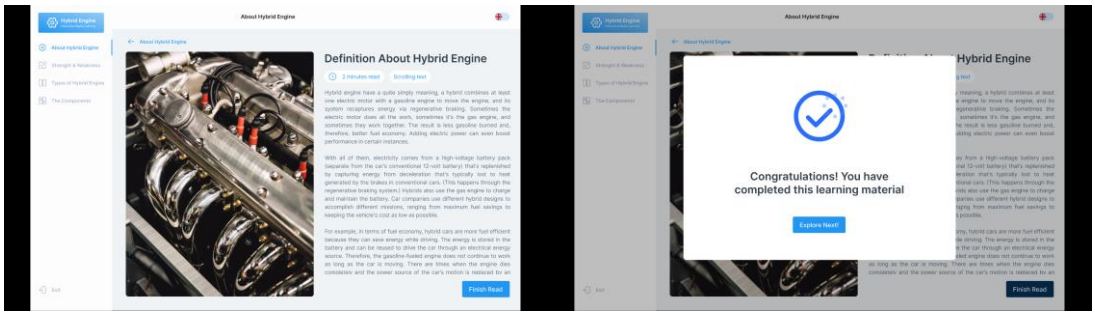

Figure 5 displays the "hybrid engine" application

DISCUSSION

The researcher used the blackbox testing method with the boundary value analysis technique to test the "Hybrid Engine" application. The first process is knowing the research flow starting from the analysis assessment to releasing the results of application testing, which can be in the form of values or data visualization. When testing the “Hybrid Engine” application, 62 test scenarios and 2 table. Of the 62 data scenarios, there are 57 consistent conclusions and 5 dissonant conclusions. These are processed using the Boundary Value Analysis technique. The effectiveness value of the "hybrid engine" application is 78.245615%. The results of these calculations can be used to test other data or are called data testing. This comparative research is entitled "Testing the Population Administration Website Application Using the Black Box Testing Boundary Value Analysis Method" written by Ginanjar Wiro Sasmito in 2020. The BVA test results showed that the application was able to handle data, both normal and abnormal, with a successful percentage of 90.9%. [20] Software Testing (Software Testing) is a stage of the process of implementing a program that aims to find an error in the application. The testing technique used is the Boundary Value Analysis (BVA) method. Boundary Value Analysis is a technique contained in the black box testing method which aims to test input values by determining the upper and lower limit values for each input data.Written by Hosea Albert Sauloman Hutapea in 2022. [21] The Boundary Value Analysis technique that has been described has been able to provide an overview of the stages and processes in testing each function. Process functionality is explained thoroughly so that readers can better understand and know the entire process in the application. Written by Putu Astya [22]. In the first stage carried out in this research is to identify the function to be processed, ensure the maximum and minimum number of digits in accordance with the specified order. The result of applying the method used is the quality of the software according to its function, and can be utilized properly by the user. Written by Siti rika [23].

CONCLUSION

Testing of "hybrid engine" applications has been successfully carried out using the Boundary-based Black Box Testing method Value Analysis by analyzing needs, identifying problems, determining test data, creating test scenarios, and determining the value of effectiveness. Based on the results of testing the "hybrid engine" application, several conclusions can be drawn as follows following :

1. The "hybrid engine" application is already running according to the specified functionality expected but there are still some bugs in the app which should be fixed soon updated.
2. The results of testing the "Hybrid Engine" application, from 62 test scenarios carried out 57 test scenarios in accordance with the expected results, and not suitable so that the value of the effectiveness of the application is equal to 78.245615%

With the completion of black box testing using the Boundary Value Analysis method regarding functional testing, after being submitted for an update according to the test results, it can be submitted for further testing, namely alpha and beta testing.

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