Blackbox Testing on Web Based Capstone Project Information System in Electrical Engineering Study Program Udayana University

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Abstract Capstone Project Information System is an information system developed to handle administrative processes related to capstone project activities in the Electrical Engineering Study Program at Udayana University. With this information system, it is expected to minimize inefficient repetitive work and reduce the potential for human error in the implementation of capstone projects. To ensure that the Capstone Project Information System can work properly in handling capstone project administration in the Electrical Engineering Study Program at Udayana University, blackbox testing is carried out, where the focus of this test is on system input and output without paying attention to the internal structure of the program code. Based on the results of blackbox testing on six user roles in this information system, it can be concluded that this system has successfully met the functional needs of various types of users. The features that have been made work well, indicating that the Capstone Project Information System has met the expected functionality criteria, indicating that this system has been well designed.

Index Terms— Information System, Capstone Project, Testing, Blackbox

I. INTRODUCTION

In the digital era which is increasingly developing rapidly, the development of information systems is very important to support various activities in all fields, one of which is in the higher education sector. Software testing is a crucial stage in the software development life cycle to ensure that the system being built complies with specifications and is free from errors [1]. One testing method that is commonly used is black box testing, where the focus of this testing is on the input and output of the system without paying attention to the internal structure of the program code [2].

The Capstone Project Information System is an information system developed to handle administrative processes related to the capstone project in the Electrical Engineering Study Program at Udayana University. The capstone project is part of the academic curriculum at the Electrical Engineering Study Program at Udayana University. Based on the 2023 capstone project guidebook, a capstone project is a final project carried out by a group of students, where students apply their knowledge and skills by implementing an engineering design process which aims to demonstrate students' practical abilities.

The capstone project was implemented to obtain accreditation from the Indonesia Accreditation Board For Engineering Education (IABEE), which is a non-profit organization responsible for ensuring the quality of education in the fields of engineering and computing at international standards [3]. IABEE focuses on implementing education based on OBE learning outcomes which will ensure the fulfillment of a continuous improvement process [3].

To ensure that Capstone Project Information System can work well in handling the administration of the capstone project at PSTE Unud, black box testing was carried out. This test aims to ensure that the system can handle input and produce the expected output without paying attention to the internal structure of the program code [4]. With this testing, it is hoped that Capstone Project Information System can operate effectively and efficiently, thereby supporting the implementation of the capstone project which contributes to achieving accreditation from IABEE.

II. LITERATURE REVIEW

Black Box Testing is a method used to test a software without having to pay attention to the software in depth [5]. This test only checks the output value based on the respective input value. There is no attempt to find out what program code the output uses [2]. Black Box Testing process by trying the program that has been made by trying to enter data on each form. This test is needed to find out the program runs as needed [6]. The advantages of black box testing are as follows [5]:

1. The tester can focus on the functionality of the system without worrying about the internals of the system.
2. Separates the tester from the developer, so the tester does not need to know how the system is implemented.
3. Helps to uncover defects and errors that are not visible from the code or system architecture.

The limitations of black box testing are as follows [5]:

1. The possibility of not being able to detect errors related to the internal workings of the system.
2. May not be able to effectively identify complex bugs or defects.
3. May not be appropriate for testing performance and security related issues.

The following are black box testing design techniques:

1. Equivalence Partitioning

   This test design used in software testing involves dividing a set of test conditions into groups or partitions that are equivalent or similar to each other [5]. The idea behind this technique is to minimize the number of test cases that need to be run while still ensuring that all possible scenarios are covered [5]. Equivalence classes can be determined based on the following guidelines [7]:

   a. If the input condition is a range, one valid equivalence class and two invalid equivalence classes will be defined.
   b. If the input condition requires a specific value, one valid equivalence class and two invalid equivalence classes are defined.
   c. If an input condition specifies a member of a set, one valid equivalence class and one invalid equivalence class are defined.
   d. If the input condition is Boolean, one valid and one invalid equivalence class is determined.

2. Boundary Value Analysis

   This test design is a software testing technique used to identify errors in software by focusing on the boundary conditions of the input domain [5]. Boundary value analysis (BVA) complements the Equivalence Partitioning test design [7]. The guidelines of BVA are as follows:

   a. If the input conditions specify a range bounded by the values of a and b, the test case should be designed with the values of a and b just above and just below a and b.
   b. If the input condition specifies a range of values, test cases should be developed that use minimum and maximum numbers. Values above and below the minimum and maximum are also tested.
   c. Apply guidelines 1 and 2 to the output conditions. For example, assume that a temperature versus pressure table is required as output from an engineering analysis program. The test case should be designed to create an output report that produces the maximum (and minimum) number of table entries allowed.
   d. If the internal program data structures have defined limits (e.g., a table has a limit of 100 entries), be sure to design test cases to apply the data structures to their limits.

3. Use Case Testing

   This test design is a testing technique used to evaluate the ability of software to meet user needs [5]. According to [5] to perform use-case testing, the first thing to do is to identify the use cases of the system and the next is to create test cases based on inputs, expected outputs and steps that should be taken. The benefits of using this test design are as follows [5]:

   a. Improve software quality by meeting user needs.
   b. Good test scope by ensuring all scenarios are met.
   c. Easy to understand so that stakeholders can easily provide feedback.
   d. Efficient testing by focusing on the most important scenarios, thus reducing effort and time for testing.

   This test design is appropriate when the system will undergo changes and is not appropriate when the system is relatively simple and lacks information related to the user's perspective [5].

Applying Black Box Testing in this SICP allows focus on the functionality of the system without requiring in-depth knowledge of the internal implementation. It separates testing from development, finding functional errors that are not visible from the code. With design techniques such as Equivalence Partitioning, Boundary Value Analysis, and Use Case Testing, it ensures user needs are met and focuses on the scenario to be achieved.

III. METHOD

SICP was developed in three iterations, where at the end of the first and second iterations blackbox testing was conducted. In the third iteration, no blacbox testing was carried out because in this iteration only improvements to the SICP function were made according to the UAT results.

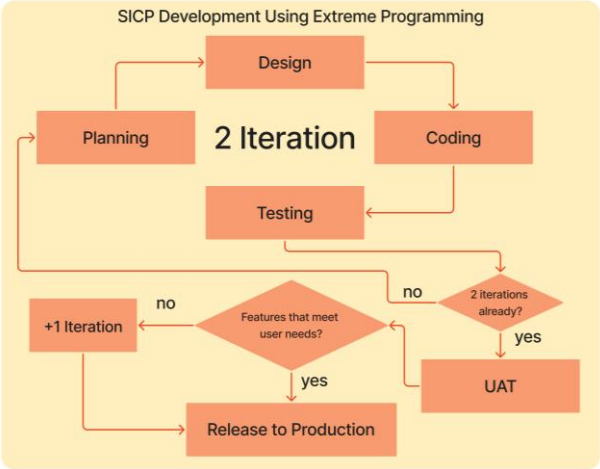

Fig. 1 SICP Development Using Extreme Programming

Blackbox testing aims to ensure that each feature developed in that iteration meets predefined standards and is in line with user requirements. With the blackbox approach, testing is done without regard to internal implementation details, so the main focus is on validating the output generated based on the input provided. This approach is particularly useful for verifying that software operates according to predefined standards, without the need to understand the underlying program code.

During the development of SICP, each iteration included hands-on testing of existing features, which were realizations of user stories reflecting user requests. SICP users are divided into six roles: student, lecturer, CP coordinator, program study coordinator, PSTE correspondence admin, and PSTE SIMAK admin. The following are some user stories from each user roles.

TABLE I
USER STORIES FROM STUDENT ROLE

As…	User Wants…	So That…
Students	Invite other students to form a CP team and lecturer as lecturer supervisor	Students have the capability to send invitations to other students, inviting them to join and form a CP (Curriculum Practicum) team. In addition, they can also invite a lecturer to take on the role of supervisor, who will provide guidance and oversight throughout the CP activities
	Upload the CP activity requirement files	Students can upload various files required as prerequisites to participate in CP activities. Once these files are uploaded, the CP coordinator will receive them for review and validation, allowing the student to proceed to the next stage
	Receive information related to CP activities	Students can access detailed information regarding the CP activities they have previously submitted. This information will help students prepare better and ensure they understand each stage in the CP process
	Revise the report that has been tested on CP activities	After the report submitted by the student has been tested by examiners, the student can view the revision notes or comments provided. The student can then make the necessary revisions to the report based on the examiner's suggestions and re-upload the revised report

TABLE II
USER STORIES FROM LECTURER ROLE

As…	User Wants…	So That…
Lecturer	Receive information related to implementation of CP activities	Lecturers can access detailed information related to the implementation of CP activities, particularly concerning the students they are supervising. This information will include schedules, tasks, and the progress of students during the CP activities
	Assessing students during the activity	Lecturers are responsible for assessing the students they supervise at each stage of the CP activities. This assessment covers various aspects, including participation, quality of work, and understanding of the material provided
	Provide a digital signature	Lecturers have the authority to create, manage, and update their own digital signatures. These digital signatures are used in various official documents related to CP activities, ensuring the validity of such documents
	Provide revision notes to students	The examiner lecturers can provide revision notes or comments to students after their reports have been evaluated. These revision notes aim to help students improve their reports to meet the expected standards

TABLE IIII
USER STORIES FROM CP COORDINATOR ROLE

As…	User Wants…	So That…
CP Coordinator	Verifying the required files uploaded by students when submitting CP activity registration	The CP coordinator is responsible for verifying all the files uploaded by students as part of the CP activity registration requirements. Only after all the files from the team members are verified and deemed complete and valid, can students proceed to the next stage of the CP activities
	Determine activity schedule, venue, and lecturer examiners for teams that have met the requirements	Once a student team meets all the required criteria, the CP coordinator will set the schedule for the activity, select the venue, and assign lecturer examiners based on the CP team's topic. This process ensures that each team receives appropriate support during the CP activities
	View the number of guidance and number of tests for each lecturer	The CP coordinator has access to data that shows the number of students being guided and examined by each lecturer. This information is used to fairly and equitably distribute the examination and

		supervision duties among the involved lecturers
	View and manage the status of attendance status of supervisors and examiners during CP activities	During the CP activities, the CP coordinator can monitor the attendance of lecturers serving as supervisors and examiners. If there are any absences or changes in attendance status, the coordinator can adjust and manage the schedule to ensure that the CP activities proceed smoothly without any interruptions

TABLE IV
USER STORIES FROM PROGRAM STUDY COORDINATOR ROLE

As…	User Wants…	So That…
Program Study Coordinator	Receive information on the implementation of CP activities	The Program Study Coordinator can receive and access detailed information about the implementation of CP activities, including the schedules and progress of all students involved. This information helps the coordinator ensure that all activities are conducted according to plan
	Providing a digital signature	As part of administrative duties, the Program Study Coordinator can create, manage, and update their digital signature. This signature is used to authenticate various official documents related to CP activities, maintaining the integrity and validity of the administrative process
	Receive statistical information implementation of CP activities	The Program Study Coordinator can access statistical data related to the implementation of CP activities. This data includes the number of participants, evaluation results, and other indicators that help in monitoring and ensuring that the CP activities are conducted well and achieve the desired outcomes

TABLE V
USER STORIES FROM PSTE SIMAK ADMINISTRATOR ROLE

As…	User Wants…	So That…
PSTE SIMAK Administrator	Verifying the final documents uploaded by students	The PSTE SIMAK Administrator is responsible for verifying the final documents uploaded by students. Once these documents are verified, the process for issuing the lecturer's assignment letter can proceed, allowing the students to move on to the next stage of the CP activities
	Receive a recap of CP 2 grades	The PSTE SIMAK Administrator is also tasked with receiving and inputting the CP 2 grades of students into the SIMAK system. This process is crucial to ensure that all student grades are accurately recorded and accessible for future academic purposes.

TABLE VIV
USER STORIES FROM CORRESPONDENCE ADMINISTRATOR ROLE

As…	User Wants…	So That…
PSTE Correspondence Administrator	Receive letter submission examiner's assignment letter and supervisor's assignment letter	The PSTE Correspondence Administrator is responsible for receiving and processing the submission of assignment letters for examiner lecturers and supervising lecturers. This process is carried out through the SIRAISA system, and once the assignment letters are finalized, they can be forwarded to the respective students so that they can proceed to the next stage in the CP activities

The user stories were meticulously crafted based on a thorough analysis of user needs and requirements. These user stories are not just a collection of features; they represent the core objectives and goals that the users aim to achieve with the SICP system. They serve as a foundational blueprint for the development team, guiding them in the creation of features that are both functional and user-centric. Given that the SICP system encompasses a wide array of functions and features, it is essential to ensure that each feature is thoroughly tested to meet the intended quality and performance standards. Therefore, we have prepared a detailed feature testing plan that focuses on the key roles involved in the system. This testing plan is divided into different phases, starting with the first and second iterations, where each role's specific functions and interactions within the system are tested comprehensively. This phased approach allows for incremental validation and improvement of the system, ensuring that by the time all features are fully developed, they work seamlessly together and provide a smooth user experience.

TABLE V
FEATURE TESTING PLAN FOR THE STUDENT ROLE (M)

Id	Scenario	Expected Result
	Iteration 1	
M01	Adding student invitations by filling in the academic year, title, student input with different names	The user will receive a success message "Data Successfully Saved", and can see the status of the logged-in user's invitation has been accepted.
M02	Upload the required files	The user will receive a success message "Data Successfully Saved", and the Upload Status of the Requirement File becomes "Uploaded"
	Iteration 2	
M03	When the examining lecturer has given a revision, students upload a revised report file with a size of less than 100 MB.	The user will receive the message success "Data Successful Saved"
M04	When the exam registration has been validated, view the activity schedule.	Users can view the schedule of activities in the form of days, dates, and hours of CP activities.

TABLE II
FEATURE TESTING PLAN FOR THE LECTURER ROLE (D)

Id	Scenario	Expected Result
	Iteration 1	
D01	Receive invitation as lecturer supervisor	Users of can receive invitations and change status invitation to 'Accepted'
D02	Giving minus grades to students during the activity	The value alert does not match the requirements so the user cannot save the value.
	Iteration 2	
D03	Approve report revisions from students	Users can approve report revisions from capstone project teams that are mentored by
D04	Creating signatures in image files of the correct format (JPEG, JPG, or PNG) and pins	The user can save the inputted signature and can view the signature on the signature page.

TABLE III
FEATURE TESTING PLAN FOR THE CP COORDINATOR ROLE (C)

Id	Scenario	Expected Result
	Iteration 1	
C01	Validate the requirement files uploaded by students and fill in comments in the comments column	The user sees the alert 'Validation data saved successfully', and the data is saved successfully.
C02	Determine the examining lecturers for each student member of the CP team	The user sees an alert 'Lecturer Tester saved successfully' and the data is successfully saved.
	Iteration 2	
C03	View Overall lecturer load (number of lecturers guiding and testing)	User view the table which displays number of lecturers guiding and testing in overall
C04	View status attendance lecturer supervisors and examiners CP	The user sees a table that displays the attendance status of all CP supervisors and examiners.

TABLE IV
FEATURE TESTING PLAN FOR THE PROGRAM STUDY COORDINATOR ROLE (K)

Id	Scenario	Expected Result
	Iteration 1	
K01	View a recap of CP activity schedules by academic year and capstone category	Users view all activities that have been scheduled according to the academic year and capstone category that has been determined.
K02	View a recap of the overall scores of CP team members by year and capstone category.	Users see a recap of all students' grades by year and capstone category.
	Iteration 2	
K03	Creating signatures in image files of the correct format (JPEG, JPG, or PNG) and pins	The user can save the inputted signature and can view the signature on the signature page.
K04	Receive statistical information on the implementation of CP activities	Users can view information statistical information in graphical form related to implementation of CP that has been running

TABLE V
FEATURE TESTING PLAN FOR THE SIMAK PSTE ADMIN ROLE (S)

Id	Scenario	Expected Result
	Iteration 1	
S01	Receive the final file of each student team member	Team members' final student files are verified and the final file status becomes 'valid'
	Iteration 2	
S02	View score recap each student at activities Capstone Project 2	Users of can view score recap of the activities activities participated in by students at the activities Capstone Project 2

TABLE VI
FEATURE TESTING PLAN FOR THE CORRESPONDENCE ADMIN ROLE (P)

Id	Scenario	Expected Result
P01	Inputting the supervisor or examiner assignment letter sheet in accordance with the submission of the supervisor or examiner assignment letter.	The supervisor or examiner assignment letter file can be accessed by the student concerned.

IV. RESULTS

Before consumers are allowed to access and utilize the SICP system, it undergoes a rigorous testing process designed to uncover any potential flaws or deficiencies that may exist within the system. This testing is crucial as it ensures that the system operates according to the specifications and meets the intended requirements before it is released for public use. The results of these tests are meticulously documented, and within these results, there is a detailed test case table. This table plays a vital role in determining whether the system has successfully passed all the necessary checks and whether it adheres to the predefined test plan. It includes various scenarios that simulate real-world usage to ensure that the system is robust and reliable under different conditions. The outcomes listed in this table provide clear evidence of the system's performance and functionality. For a comprehensive overview of the results from these tests, one can refer to TABLE VII, which displays the meticulously prepared and analyzed test outcomes. This table is a critical component of the quality assurance process, serving as a key indicator of the system's readiness for deployment.

TABLE VII
TESTING RESULTS

Id	Test Result	Conclusion
M01	***Passed***	Scenarios and results have worked as expected
M02	***Passed***	Scenarios and results have worked as expected
M03	***Passed***	Scenarios and results have worked as expected
M04	***Passed***	Scenarios and results have worked as expected
D01	***Passed***	Scenarios and results have worked as expected
D02	***Passed***	Scenarios and results have worked as expected

D03	***Passed***	Scenarios and results have worked as expected
D04	***Passed***	Scenarios and results have worked as expected
C01	***Passed***	Scenarios and results have worked as expected
C02	***Passed***	Scenarios and results have worked as expected
C03	***Passed***	Scenarios and results have worked as expected
C04	***Passed***	Scenarios and results have worked as expected
K01	***Passed***	Scenarios and results have worked as expected
K02	***Passed***	Scenarios and results have worked as expected
K03	***Passed***	Scenarios and results have worked as expected
K04	***Passed***	Scenarios and results have worked as expected
S01	***Passed***	Scenarios and results have worked as expected
S02	***Passed***	Scenarios and results have worked as expected
P01	***Passed***	Scenarios and results have worked as expected

Based on the tests carried out, it can be seen that all tests were successful and met the expectations of the testers. This confirms that the Capstone Project Information System (SICP) is running well and can be used immediately.

V. CONCLUSION

Based on the results of testing the Capstone Project Information System (SICP), it shows that testing using the blackbox method is very helpful both in the process of preparing test cases, testing functionality and finding error gaps that can be detected when an input error occurs. After conducting several test cases, it can be concluded that the Capstone Project Information System (SICP) has no functionality errors in each feature. So that the information system runs well and is ready to use.

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