Library System Development Using Design Thinking Method

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Abstract.

The library information system that is currently being used is still inadequate in providing information and various problems occur on the website which disrupt various transaction activities in the library. The aim of creating this website is to provide facilities for all users, from librarian, and students to lecturers, to obtain library information easily. The website will be built with various features in the hope of making it easier for users to get information from the library. Using the design thinking method, research is carried out to identify problems that occur and solutions are found according to the needs of library users. Based on the results of the usability test, the score was above average and in the good category and this system can be generally accepted by all users. Even though the usability results were unsatisfactory, the majority of users, 82.41%, were satisfied with this library system. The performance test results also show that the website has very good performance with an average score of 92.68%.

Keywords: *Design Thinking, User Centered Design and Academic Library.*

I. INTRODUCTION

Academic libraries are fundamental entities for providing knowledge to information users and are the heart of education [1]. Libraries serve as educational, information, and recreational centers, with academic libraries collecting, managing, and presenting library materials as sources of information so that users can make the best use of them and broaden the scope of library services [2]. Each academic library is responsible for serving its parent institution's information needs and contributes significantly to teaching, learning, and research in colleges [3]. However, it is frequently seen that academics do not have adequate libraries, as a result, students and lecturers do not have good access to information resources which hinders the teaching and learning process. The availability of the internet and the digitalization of resources, as well as the impact of information and communication technology, are among the most important aspects impacting how libraries operate today [4]. Users have abandoned academic libraries as a result of different information technology-related advances, the shift to digital services, and the growing need for new services [5].

Academic libraries must adapt to their communities' changing requirements while keeping their historic responsibilities as repository of knowledge and facilitators of intellectual growth [3]. Academic libraries are undergoing a significant change, from physical building that store and provide access to information to dynamic platforms that enable knowledge creation, collaboration, and innovation. Libraries are adopting digital technology, growing their online presence, and providing virtual services that go beyond the physical bounds of their buildings [6].This research aims to make it easier for librarian to carry out borrowing, returning, extending, and ordering collections in the library, to make it easier for students and lecturers to see information librarys' collections, borrowing lists, borrowing history and returning collections along with fines obtained from late returns as well as processing and displaying administrative data reports on the web-based Library Information system automatically and accurately. The design thinking method is carried out in this research to identify problems that occur and solutions are found according to the needs of library users

II. METHODS

Design Thinking is an iterative, human-centered approach to problem-solving that takes into account user lifestyles and related consumption choices in addition to the product, which is essential for developing systematic solutions to sustainability concerns [7]. The design thinking approach supports the development process with a thorough understanding gained via direct observation of potential users as a target to learn about their requirements and preferences as well as actions that are quite effective in determining solutions [8]. Using a Design Thinking approach makes it more likely to create products and services that truly provide a positive sustainability effect [7]. In order to create products that meet user needs, iteratively, products must start with an empatic focus on research on potential users to truly understand humans, looking at problems from various points of view and determining varied solutions, conducting team testing, and getting feedback from the product samples provided to potential users [9]. User-centered DT-based approachs facilitate the creation of more functional prototypes [10], and encourage effective integration of technology into society [11]. Five stages of design thinking according to d. school are:

Emphathize

This stage focuses on the user using the product to gain a firm understanding of the problem. In the early stages of designing an innovative product, user research is carried out to determine user needs [8]. The main goal is to develop an understanding of users, their needs, and problems so that the product meets user needs [12].

Define

This stage is used to collect information obtained in the previous stage, analyze it and create a comprehensive understanding to determine the core of the identified problem [13]. Defining tasks leads to creating a project summary that details specific tasks [14]. At this stage, the core of the problem will be found which will be the main goal of making the product.

Ideate

This stage is used to find innovative solutions to problem statements. Ideate is carried out by evaluating several creative ideas that have been determined from the results of the definition stage [12]. Ideation can be done by brainstorming to create the best, most effective solution [13].

Prototype

This stage is used to create a prototype from the ideas obtained in the previous stage. Making prototypes is more directed at fulfilling the learning model so that we can find out the reliability of the solution produced from the previous stage [15]. From the results of this investigation, limitations and problems faced as well as solutions will be obtained. Prototyping is carried out to allow potential users to interact directly and provide feedback on the product [15]. From the results of this interaction, a clearer picture of how users behave, think and feel when interacting with the final product will be obtained.

Test

At this stage, the product will be tested as a whole using the best solution identified at the prototype stage to measure the effectiveness and efficiency of the product [12]. At this stage, in Design Thinking's iterative process, the results are often used to redefine future problems. This increased level of understanding to user conditions, behaviors, and feeling towards service or product. The main objective is to gain a comprehensive understanding of both the product and its users.

III. RESULT AND DISCUSSION

At interviews and observations during empathy stage, several workflow issues were revealed at the library. It was observed that transaction data often cannot be entered directly on the website due to freezing, so it is recorded manually on paper. During reservations, collection code, names and reservers' names are manually recorded. Late returns are frequent, with no system to notify reserver about collection availability or return date. Proposals to acquire new collections are documented on paper until purchase. Borrowers are responsible for remembering return due dates themselves, as librarians do not consistently monitor transactions or provide reminders. Interviews also uncovered delays in returns, issues with updating transaction statuses in the system, and inconsistencies in the book collection code structure, requiring

librarian to re-learn code periodically. At the define stage, analysis and categorization of the problems obtained in the previous stage are carried out. In the previous system, freezes often occurred which affected library operations, several sections in the system were unavailable and several reports failed to generate accurate data. Reservation of the collections, proposing new collections, and entering user data for libraries are still done manually. As a result, many items are frequently overlooked and poorly integrated.

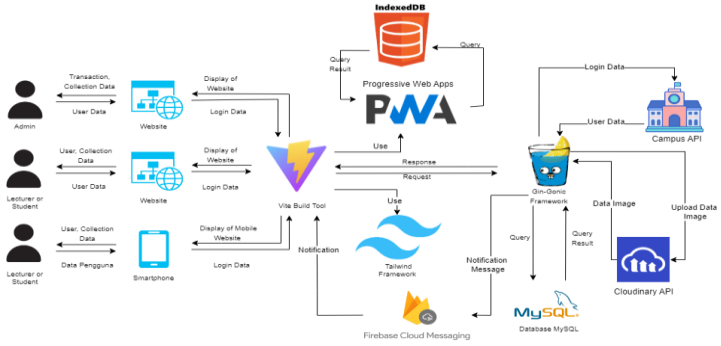

Fig 1. Architecture System

The outcome of the ideation stage is the system architecture that will be used in the system. The website is designed with a responsive layout using TailwindCSS, and utilizes the Gin Framework for its performance, usability dan adaptability. Users can use the website like a native mobile application and several features offline with the help of Progressive Web App and IndexedDB. Firebase Cloud Messaging API is used to get notifications and Cloudinary API is used to facilitate image storage management.

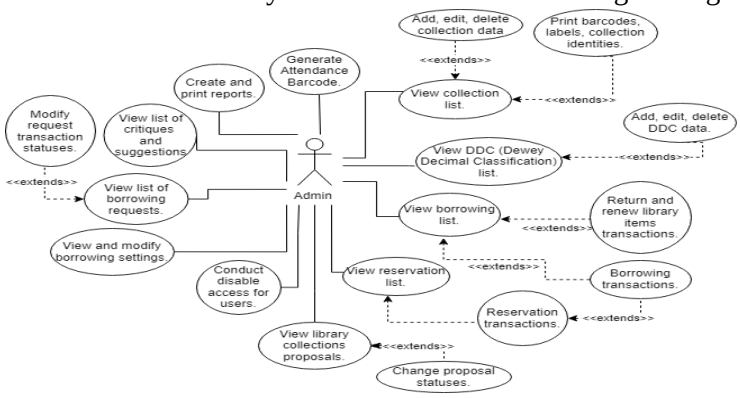

Fig 2. Use Case Admin (Librarian)

There are three interconnected actors in this library system. The actors are admin (librarian), student, and lecturer. Each actor starting from admin and user has different access rights. These features consist of features that can be accessed by all users and features that can be accessed if the user logs in first. Login aims to enable users to access various special features.The admin (librarian) must login first to be able to access the features. The admin use case can be seen in Figure 2. There are various useful features to support the admin's needs in managing the library. Admin features include viewing, adding, and editing all information held by the library, circulating in the library, making transaction, and making library reports.

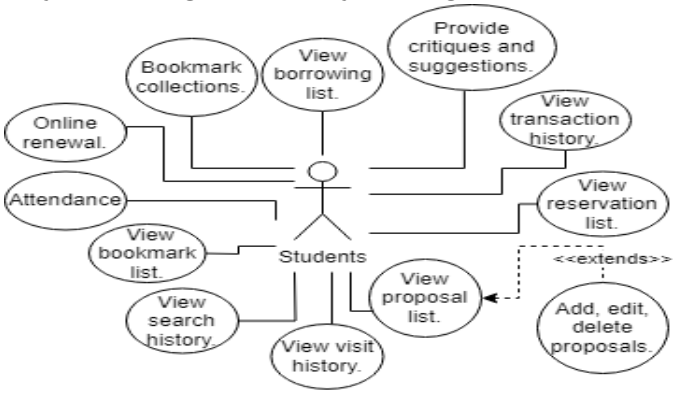

Fig 3. Use Case Student User

Student and lecturer users must log in first to be able to access various special features. The use case of student users can be seen in Figure 3. There are various useful features to support user needs in viewing all transactions that have been carried out in the library, there are reminders in the form of notifications regarding changes to transactions made by users.

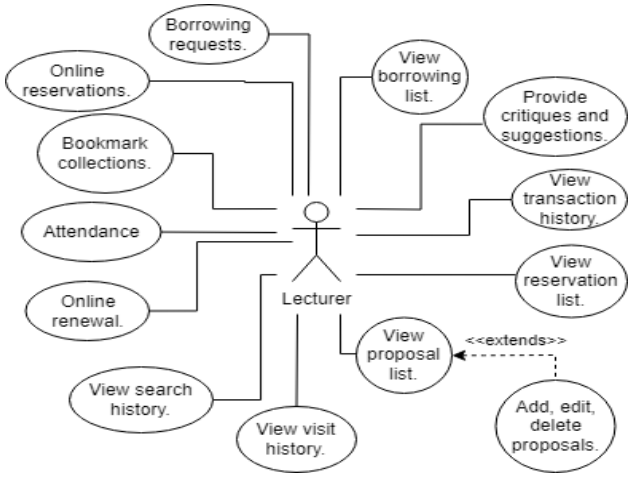

Fig 4. Use Case Lecturer User

Student and lecturer users have the same features. Lecturer users can use all the features that can be used by student users. The difference is in the borrow request feature and notifications if the admin changes the request status. Apart from the differences in features, there are differences in the maximum borrow settings, daily fines, and borrowing time. Use cases from lecturer users can be seen in Figure 4.

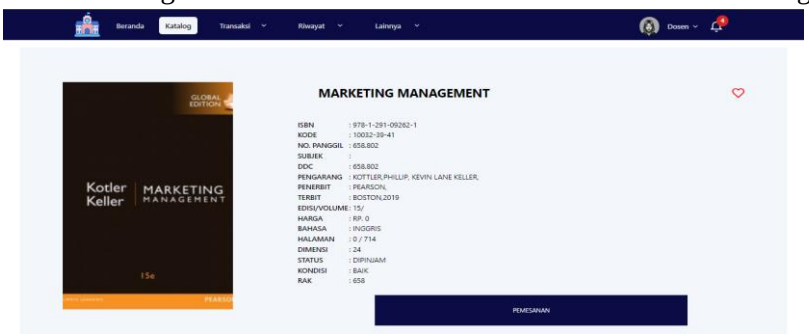

Fig 5. Detail Page

At the prototype stage, a website prototype is created based on the solution that was created previously. Figure 5 is an image on the details page of a collection. In the details page of a collection, users that log in can bookmark the collection. Reservation and order requests are available for lecturer users.

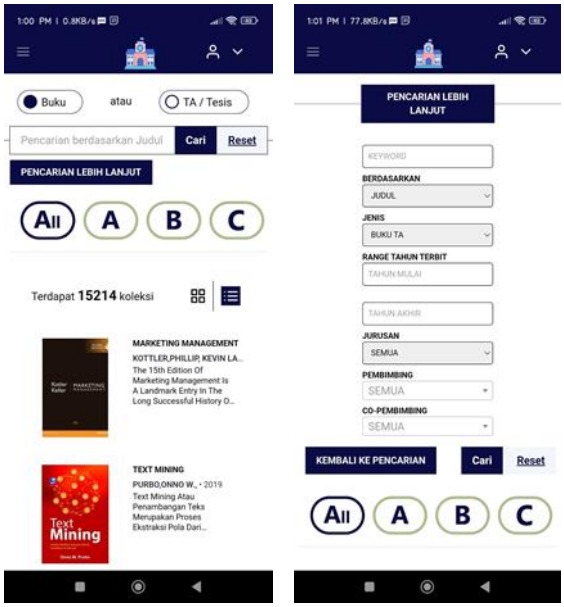

Fig 6. Catalog Page

Figure 6 is an image of the catalog page when accessed using a smartphone. On the catalog page, users can perform both simple and advanced searches, and filter collections by title. By default, the catalog page initially displays collections in a grid format under the simple search option.

Fig 7. Borrow History Page and Order List Page

The borrow history and order list pages are accessible only to users that already login. On the borrow history page, users can view all historical data with a status filter. On the order list page, users can view all order data with a status filter and have option to cancel orders if the status is still pending. The report page is restricted to admin users only. It allows user to generate visitor reports based on year, displayed as a line graph showing annual number of visitors. User have the ability to modify the graph type dan data displayed using filters.

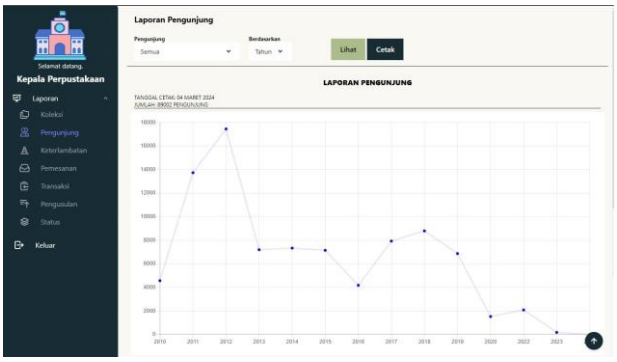

Fig 8. Visitor Report Page

During the testing phase, two tests are conducted: performance and usability testing of the system. The performance test assessed how quickly and efficiently the website performs tasks on its pages, using Google Lighthouse. This included evaluating performance, accessibility, best practices, SEO, and PWA capabilities. Calculations were conducted based on data from a total of 34 pages on the website, which can be seen in Figure 9. The Performance score was very good at 92.68. The Best Practices score was quite good at 80.26. Accessibility received a very good score at 99.65. However, the SEO score was lower, at 78.5 because the website link cannot be crawled and some *img* elements do not have an *alt* attribute.

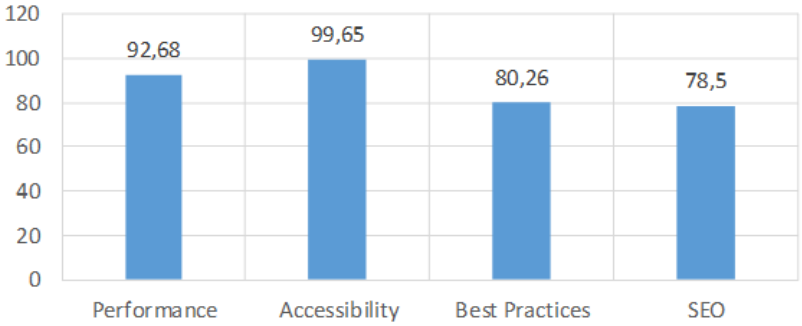

Fig 9. Average Performance Test Score Graph

Usability tests for this system will involve 1 librarian, 20 lecturers, and 56 students. The System Usability Scale (SUS) questionnaire method will be used to evaluate the usability system. SUS is used to obtain a measure of users' subjective views of system usability with 10 questions rated on a 5-point Likert scale [16]. Respondents rate their agreement with statements in the questionnaire. Score for each item ranges from 0 (strongly disagree) to 4 (strongly agree). Equation 1 is used to calculate the SUS score [17].

$$SUS\ Score = \{(S1-1)+(5-S2)+(S3-1)+(5-S4)+(S5-1)+(5-S6)+(S7-1)+(5-S8)+(S9-1)+(5-S10)\} \times 2.5 \quad (1)$$

Si represents the number of statements adjusted according to the rules. Odd items (1,3,5,7,9) with positive words contribute a scale position minus one. Even items (2,4,6,8,10) with negative words contribute a score of five minus the scale position. The overall SUS score for each respondent is calculated by adding up all the individual scores and multiplying the total by 2.5 [18]. After calculating the SUS value for each respondent, the average of all respondents' result is obtained using Equation 2, where Xi represents the sum of SUS scores for all respondents. SUS score results range from 0 to 100. However, the SUS score cannot be interpreted as a percentage result.

$$Nilai\ rata - rata = \sum_{i=0}^{n} \frac{xi}{n} \quad (2)$$

Figure 10 is a scale used to interpret the SUS score results in five ways: percentile ranking, ranking, nature, acceptance level, and Net Promotor Score (NPS) [19]. NPS indicates how willing users are to recommend the system, while acceptance level measures its user acceptance. Adjectives describe the system's nature and grade indicates the ranking of the system.

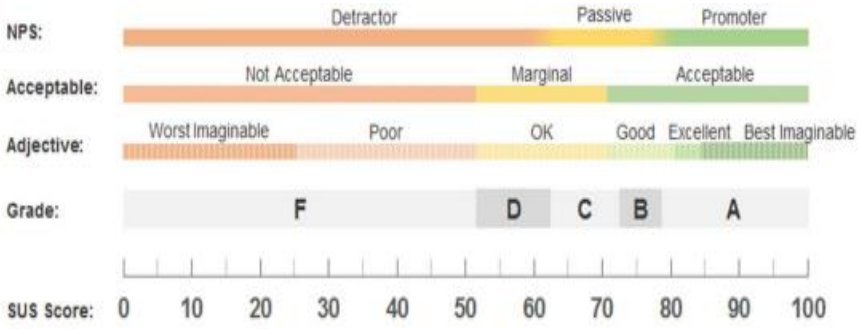

Fig 10. Scale for Interpreting SUS Score Result

When converting SUS score results into percentile rankings, a curve line tool is used as shown in Figure 11. This graph, developed by J Sauro using the scale from Figure 10. Using the graph, it can be concluded that a SUS score of 68 (grade C) with the percentile rank of 50%, which is the standard value for interpreting SUS values [16].

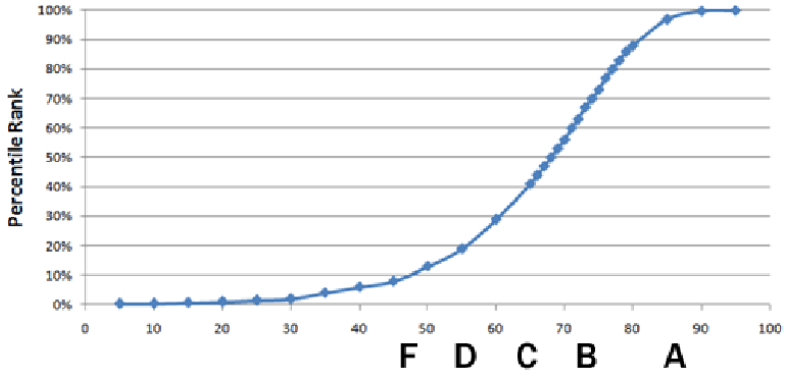

Fig 11. Sauro Curve Graph

The responses were collected from 77 respondents, with the total SUS score for the library website is 72. Based on this score, it can be concluded that the usability aspect of the system received a grade of C+ with a percentile ranking in the range of 63%, which is above average. According to characteristic based interpretation, the system is in the "good" category, and in terms of acceptance leve, it is generally accepted by users. However, based on NPS interpretation, the system is in the "passive" category, that indicates users are neither refusing or endorsing the system.

Table 1. Interpretation of SUS Test Score Result I

Respondents	Grade	SUS Score	Range	Adjective	Acceptable	NPS
Librarian	C-	63	35 - 40	OK	Marginal	Passive
Lecturer	C-	64	35 - 40	OK	Marginal	Passive
Student	B	75	70 - 79	Good	Acceptable	Passive
Total	**C+**	**72**	**60 - 64**	**Good**	**Acceptable**	**Passive**

Table I displays the interpretation of SUS scores in the initial test of this system. The total SUS score from all respondents indicated an unsatisfactory score. As a result, the system underwent changes bases on critical feedback from lecturers and students during testing. A re-test was then conducted with 10 out of the 20 lecturers who participated initially.

Table 2. Interpretation of SUS Test Score Result II

Respondents	Grade	SUS Score	Range	Adjective	Acceptable	NPS
Lecturer	C-+	72	60 - 64	Good	Acceptable	Passive

In the second test, lecturers scored the SUS system at 72, which can be indicated as a significant increase from the first test. Table II provides the interpretation of SUS scores in the second test among lecturer respondents. According to them, the usability aspect of the system received a grade of C+ with a percentile ranking of 63%, which is above average. Based on characteristics, the system is in a “good” category, and in terms of acceptance, it is generally accepted by lecturers. However, based on NPS, the system falls into the “passive category”, that indicates users are neither refusing or endorsing the system. Apart from using the SUS Questionnaire which will determine the usability and learnability of a system, an additional USE Questionnaire satisfaction section was added to get the percentage of satisfaction with using this library system. This method uses a questionnaire consisting of 7 questions with a 7-point Likert scale [20]. Respondents were asked to rate how much they agreed with the statements in the questionnaire.

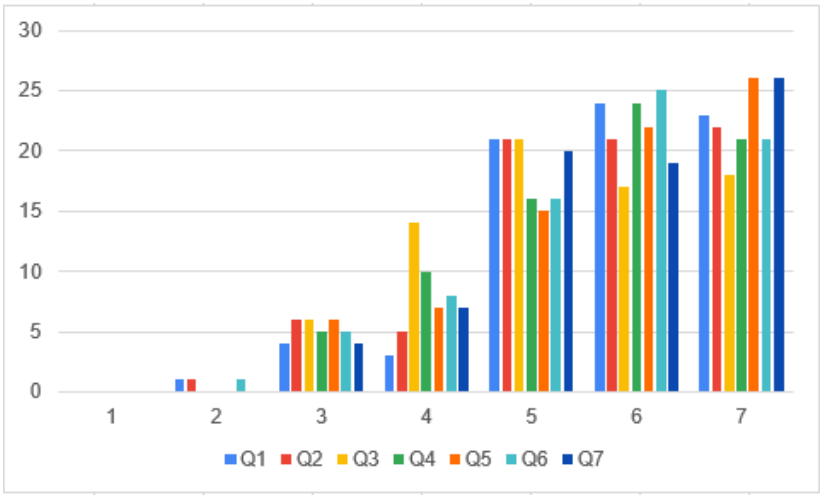

Fig 12. Uji Coba Satisfaction Pengguna

In Figure 12, satisfaction testing values for 76 student and lecturer respondents are presented: 29.5% very satisfied, 28.57% satisfied, 24.3% quite satisfied, 10.14% neutral, 6.79% quite dissatisfied, 0,56% were dissatisfied and 0% were very dissatisfied. Based on the results, the majority of respondents, 82.41%, were satisfied with the library website. However, there were 7.35% of respondents who felt dissatisfied.

IV. CONCLUSION

The usability score by librarian was 63, indicating an usatisfactory grade of C- with a percentile ranking around 36%, which is below average. This suggests librarians neither refuse not endorse the system, finding it more complex that the previous system and requiring time to learn. Despite the low usability score, librarian felt 71.43% satisfied with this system. For student and lecturer users, the usability score was 72 among 76 respondents, indicating a satisfactory grade of C+ with a percentile ranking around 63%, which is above average. The system is generally accepted and categorized as good by users, with 82.41% expressinf satisfaction. Additionally, the system performs very well, achieving an average score of 92.68% in Google Lighthouse test.

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