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Analysis and design of UI and UX of the Taring application using goal-directed design and cognitive walkthrough methods

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Abstract: Taring is a web-based application used for online administrative services for both Indonesian citizens and foreign nationals in the field of population administration. It is published by the Denpasar Population and Civil Registration Office. The taring application was released on June 8, 2020, and includes features such as managing Family Cards, e-IDs, Change of Residence Letters, and Legalization. Analysis and evaluation of the Taring application are necessary to improve usability, quality of use, and the provided information. This is achieved through the utilization of the Goal-Directed Design method and the Cognitive Walkthrough method in its process. The employed analysis and design method is Goal-Directed Design, which focuses on designing and developing interactive systems to make them more useful, with a focus on the diverse goals of the users. The evaluation methods used are the Cognitive Walkthrough and the System Usability Scale questionnaire, which assess usability and the application's usage based on observations of the users. The results of the Cognitive Walkthrough testing revealed 20 issues related to user interface and user experience, while the research findings indicated an increase in effectiveness and efficiency. The research also demonstrated an improvement in usability using the System Usability Scale method, with the score rising from 50.8 (E) to 88.9 (A).

Keywords: cognitive walkthrough, goal-directed design, system usability scale

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Introduction

The rapid development of websites has made human activities and needs easier. Various business processes can be carried out. Technology related to the Internet is widely utilized as a solution for the majority of existing needs, particularly those about effectiveness and efficiency in activities and procedures [1]. The design of a website is closely related to the comfort and user experience in using it, and it involves user interface and user experience. A well-designed interface can enhance easy and natural interaction between users and the system, improve user satisfaction, and encourage repeat visits to the website. The process of design is intricate and consists of multiple steps that require skills such as logical thinking, innovative ideas, strategic planning, and effective problem-solving abilities [2].

User interface and user experience are closely linked to the usability of the website itself. User experience, or customer experience, refers to the overall process of user interaction with a product or service and their responses to it [3].

The author wishes to conduct research by focusing on analyzing problems and evaluating improvements in the user interface and user experience of the Taring Application. The Taring Application is used for online civil registration services for both Indonesian and foreign citizens, and it is published by the Denpasar Civil Registration and Civil Service Office.

The identified problems include uncomfortable color choices. The login and registration interfaces need improvement in terms of button placement and font size. The use of irrelevant images, lack of information, and lack of dynamism due to no changes when selecting sidebar

features can confuse users. These problems are supported by reviews on Google Reviews, with a total score of 3.0 out of 5.0 based on 383 reviews. Users complain about the lack of complete information in the Taring Application, which forces them to repeatedly visit the Denpasar Civil Registration and Civil Service Office to handle their population-related matters.

The importance of usability testing in applications is explained in a similar study that discussed an online student learning application called MejaKita. Design improvements were made using the Goal-Directed Design method, and usability testing was conducted by measuring three variables: effectiveness, efficiency, and user satisfaction using the System Usability Scale method [4].

A similar study focused on usability testing of the Forum Politeknik Statistika STIS website using the Cognitive Walkthrough method. The research results showed a decrease in the error rate from 11 errors to 3 errors and an improvement in the completion rate from 0% to 66.6% among respondents after the website's display was modified and improved. This research contributes to this study by examining and utilizing the Cognitive Walkthrough method [5].

A case study of the Schoters Education Consultant Application using the Goal-Directed Design (GDD) method for its design. The research utilized the Cognitive Walkthrough and System Usability Scale (SUS) methods for analysis and evaluation, resulting in an overall usability improvement of 20% based on the Cognitive Walkthrough and System Usability Scale questionnaire. The referenced research is included in this study because it employs the same method with different cases [6].

A similar study was conducted focusing on evaluating the user interface and user experience of the Dua Mata application, which had an outdated design. The research used the Quality in Use Integrated Measurement (QUIM) method to identify usability problems in the old design. QUIM involves 25 questions with 10 standard factors to calculate the scale of problems experienced by application users. The findings demonstrated that the use of the Goal-Directed Design method improved the previous QUIM scores and reduced the completion time for each task scenario. The referenced research is included in this study because the Goal-Directed Design method has been proven to enhance the usability of an application [7].

To assess the effectiveness of the Cognitive Walkthrough method, a study compared the results of usability evaluations using three different methods: Usability Testing, Cognitive Walkthrough, and Heuristic Evaluation. The objective was to identify usability issues and compare the problems identified by each method [8].

The study conducted the evaluation and design of the Jawa Timur Park Group website using the Goal-Directed Design and System Usability Scale methods. After implementing improvements in the website design of Jawa Timur Park Group using the Goal-Directed Design method, there was an increase in the average results of the System Usability Scale. The referenced research is included in this study as a reference for the procedures and workflow of the Goal-Directed Design method and the System Usability Scale [9].

The authors' research differences from previous research in the different case studies being examined. The author wishes to generate user testing data obtained through the Cognitive Walkthrough method and recommendations for improvement in application design using the Goal-Directed Design method. The recommendations provided may involve interface enhancements or functional improvements, enabling the application design to be further optimized and focused on meeting the needs and objectives of the users.

Methodology

The design of the user interface for the Taring website is conducted using the Goal-Directed Design method, which is designed to focus on different user goals and involves users from the beginning to the end of the design process. The method involves six phases of research: Research, Modeling, Requirement, Framework, Refinement, and Support [10].

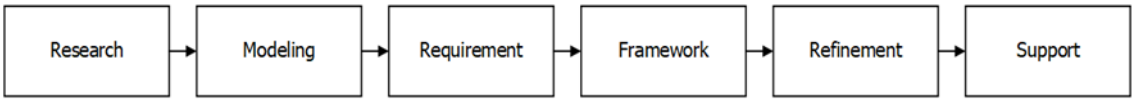

Figure 1. Research flow of goal-directed design method

Figure 1 shows an overview of the process flow of the design method. The entire flow is carried out in stages starting from the investigation process of the case study at the research stage to the testing and evaluation stages of the design results. The description of each stage of the flow is explained below.

1. Research

Employs ethnographic techniques (observation, interviews, questionnaires, or other data collection methods) to generate qualitative data about potential users or actual users of a product [11]. Usability testing is conducted using the System Usability Scale (SUS) method with 10 questions that must be answered by respondents after performing the task scenario.
The questionnaire with the System Usability Scale method uses the Likert scale as the calculation scale. The assessment is based on three categories based on the final SUS score with a range of values as in Table 1 below.

Table 1 SUS score range category

No	Score Range	Grade Scale	Acceptability Range
1	Score >= 81	A	Acceptable
2	Score > 68 and Score < 81	B	
3	Score = 68	C	Marginal
4	Score >= 51 and Score < 68	D	Not Acceptable
5	Score < 51	E	

The final SUS score is in the range of 0-100 as shown in Table 1. Based on the final SUS score, it can be identified how high the level of usability and acceptable design of the application system developed [11].

2. Modelling

The data obtained from the Research phase are used to model the users. Personas represent the observed and identified behaviors, attitudes, goals, and motivations of the users and are intended to understand what the users need.

3. Requirement

Scenario-based design methods are used to describe the detailed flow of tasks based on the personas' goals obtained in the previous phase. The goal of the Requirement phase is to balance the users' needs, business requirements, and technical aspects of the required design [12].

4. Framework

It involves designing the interaction between frameworks using visual tools. In this phase, the elements of existing functions, such as website wireframes and scenarios depicting how users interact with the system, are defined [13].

5. Refinement

Focuses on the detailed design development of each component or element of the user interface, such as determining the visual style, icons, colors, and other visual elements that align with the users' goals and experiences.

6. Support

Involves evaluating and testing the interface design. The Support research will use the Cognitive Walkthrough method to evaluate the created design.

Cognitive Walkthrough is a usability testing method that evaluates one or more aspects through several task scenarios and a set of questions to uncover issues from a user perspective. The Cognitive Walkthrough method evaluates each step taken by respondents to complete task scenarios in an application. Evaluating each step is necessary to conduct scenarios and identify usability problems that hinder user exploration.

Usability is derived from the term "usable," which generally means being capable of being used effectively. Something can be considered highly usable if failures in its use can be eliminated or minimized while providing benefits and satisfaction to the users [14]. Usability testing, employing techniques, focuses on assessing the level of usefulness provided by a system [15].

Usability testing using the Cognitive Walkthrough method consists of two stages: preparation and execution. The preparation stage involves reviewing the literature, studying the system being tested, selecting respondents, and developing task scenarios that need to be completed by the respondents. The execution phase involves the sequence of walkthrough actions and problem recording. The usability testing aligned with Goal-Directed Design, which is inherently focused on behavioral design, thus making it the chosen testing method for this research [16].

Usability testing is conducted concurrently with task scenario testing. The testing is performed using the System Usability Scale method, which involves 10 questions that respondents must answer after completing the task scenario. The System Usability Scale is an evaluative method for usability that can yield satisfactory results based on considerations of small sample size, time, and cost [17]. The System Usability Scale also possesses clear instruments on calculation methods for evaluating an application. Consequently, the resulting evaluation scores possess accuracy and accountability [18]. The results from the System Usability Scale are tested to ensure the research results are valid and reliable. Validity testing measures the extent to which a research instrument can produce actual variables. Reliability refers to the degree to which a measurement instrument can be trusted or relied upon. Reliability is defined as the level of confidence in the results of measurement [19].

Results and Discussions

In this study, the author used the Goal-Directed Design method which involves Research, Modeling, Requirement, Framework, Refinement, and Support.

1. Research

The scope for determining the users of the Taring application is limited to the residents of Denpasar, Bali, as the Taring application specifically caters to population and civil registration within that area. The users are divided into two categories: those who have previously used the Taring application and those who have never used it. During this research phase, an analysis is conducted through the distribution of a user needs questionnaire to comprehend the objectives and requirements of the users.

2. Modeling

In the Research phase, the analysis results are translated into concise, compact, and clear visual representations. These visual representations take the form of user personas, which serve as a guide for designing the user interface in the Requirement phase. User personas encompass the goals, motivations, needs, and constraints of both existing users and potential users.

For ease of reading and comprehension, findings are presented first followed by discussion. The Findings sub-title and Discussion sub-title are presented separately. This section should occupy the most part, a minimum of 60%, of the whole body of the article.

Figure 2. User persona

The user Persona in Figure 2 is an element that encompasses respondent characteristics to aid in design development. User Persona is created to summarize and synthesize questionnaire results to understand the target audience and their needs.

3. Requirement

The Requirement phase involves describing the detailed flow of tasks based on the personas' goals obtained in the previous phase. In this phase, task scenarios are tested using the Cognitive Walkthrough and System Usability Scale methods. Testing a new or ongoing system is necessary to ensure that the system functions according to the expected functionality and that any errors or deficiencies can be detected and rectified promptly [20].

a. Effectiveness

The effectiveness result indicates how many respondents were able to complete the task scenarios performed in the tested application.

Table 2. Users' results of effectiveness

Respondent Code	Successful Tasks	Total Task Scenarios	Percentage	Average Percentage
KR1	57	58	98.27	97.41%
KR2	57	58	98.27	
KR3	56	58	96.55	
KR4	56	58	96.55	
KR5	56	58	96.55	
KR6	56	58	96.55	
KR7	57	58	98.27	
KR8	57	58	98.27	
KR9	57	58	98.27	
KR10	56	58	96.55	

Table 2 shows the level of effectiveness at 97.41% of task scenarios completed when using the Taring application. Out of 58 scenario tasks that were put forward, an average of 56 to 57 scenarios were completed.

Table 3. Potential Users' Results of Effectiveness

Respondent Code	Successful Tasks	Total Task Scenarios	Percentage	Average Percentage
KR11	56	58	96.55	95%
KR12	54	58	93.1	
KR13	55	58	94.82	
KR14	54	58	93.1	
KR15	57	58	98.27	
KR16	54	58	93.1	
KR17	54	58	93.1	
KR18	54	58	93.1	
KR19	57	58	98.27	
KR20	56	58	96.55	

Table 3 also indicates a high result for the average percentage from all task scenarios. with the lowest number of successful tasks being 54, and 57 for the highest number of successful tasks.

b. Efficiency

The efficiency result represents how quickly respondents were able to complete the task scenarios performed in the tested application.

Table 4. Users' Results of Efficiency

Average Time	129.4 seconds
Successful Task Durations	7257 seconds
Total Task Duration	7507 seconds
Overall Relative Efficiency	96.7%

On the efficiency factor, the results of the task for the test scenario also show exceptional results as shown in Table 4. The overall relative efficiency of 96.7%, which obtained from the results of calculating the percentage between the number of successful task durations and the total durations of the task.

Table 5. Potential Users' Results of Efficiency

Average Time	158.6 seconds
Successful Task Durations	7596 seconds
Total Task Duration	9201 seconds
Overall Relative Efficiency	82.5%

Table 5 shows the results of overall relative efficiency, also derived from calculating the percentage of comparison between successful task duration and total task duration. The percentage of overall efficiency gives a smaller value than before, which indicates that the results of the task scenario on potential users give a lower value in the efficiency aspect than the scenario tasks performed on users.

c. Usability Level

The usability level refers to the usability result obtained using the System Usability Scale method from respondents who have performed the task scenario tests.

Table 6. Results of Usability Level

Total Number of Respondent Scores	1016
Usability Level	50.8
Grades	E (Not Acceptable)

The questionnaire is used in testing the usability level. Table 6 shows the results of application usability results which indicate unfavorable results obtained from testing users with a score of 493 or 49.3 and prospective users giving a score of 523 or 52.3. Where the overall average score is 50.8 which is categorized as not acceptable.

4. Framework

The Framework phase is the stage of designing low-fidelity mockups in the form of wireframes. Wireframes are created based on user needs and serve as a guide or foundation for creating mockup designs, which are then further refined during the prototyping phase.

5. Refinement

The Refinement phase is focused on developing detailed designs for each component or element of the user interface, such as determining the visual style, icons, and colors. The design is created based on the low-fidelity mockup created in the previous phase and transformed into a high-fidelity mockup.

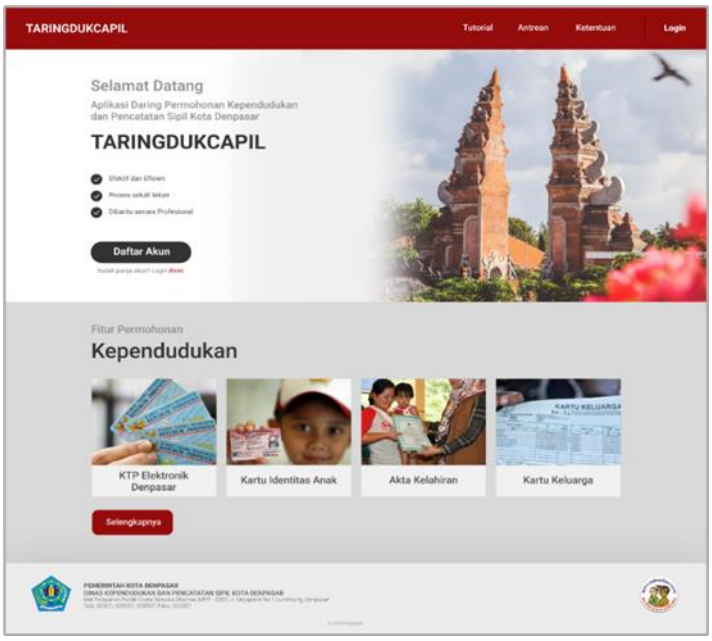

Figure 3. Mockup of homepage

Figure 3 is the mockup design for the Homepage. The design applies a different visual concept from the previous design but still maintains the essence of the website. The homepage is designed with an attractive appearance with a clean and simple interface.

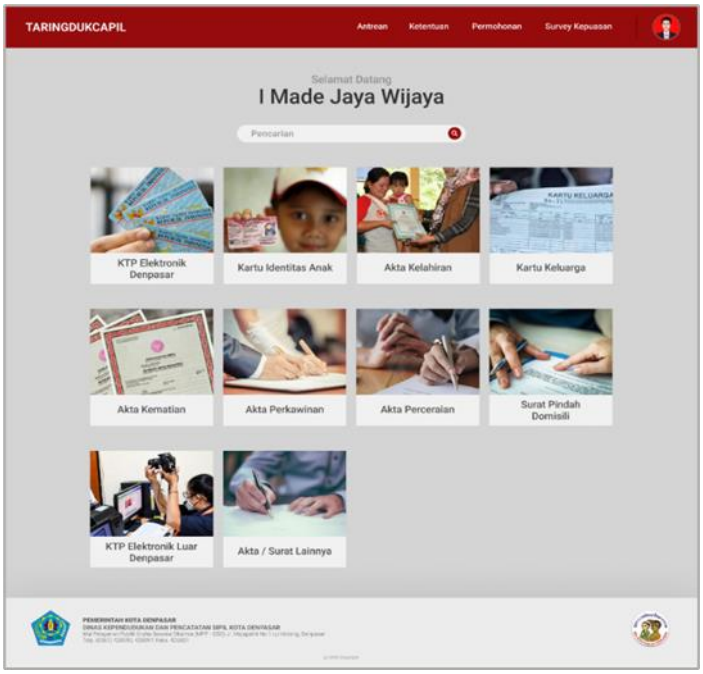

Figure 4. Mockup of feature page

The mockup of the Feature Page is shown in Figure 4. The service feature view is displayed by applying containers to represent each feature. The feature is also accompanied by a description of the image to make it easier for users to understand the usefulness of the service.

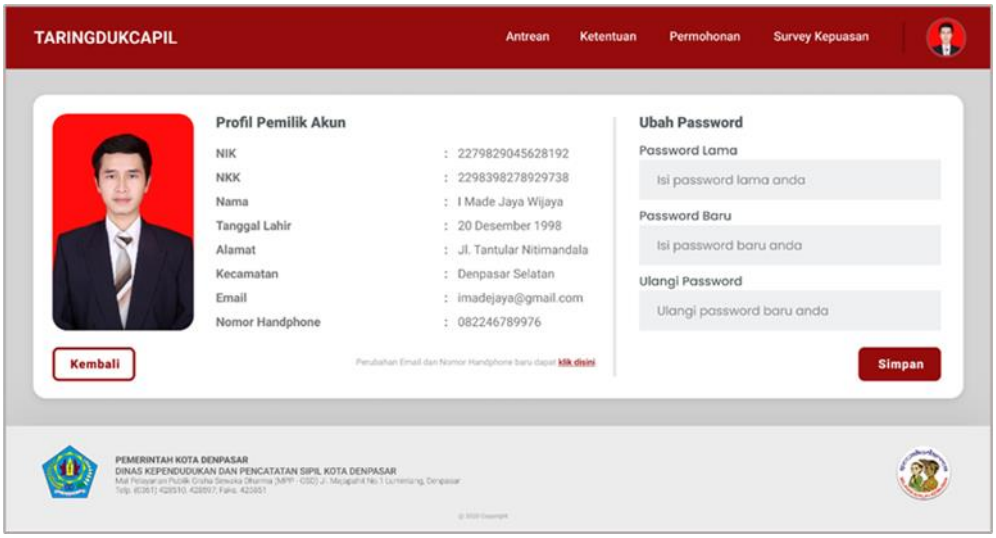

Figure 5. Mockup of the account profile page

Figure 5 is the mockup design for the Account Profile Page. The account profile page section displays user identity data. In addition, users can also change the password for the account directly on this page.

6. Support

The Support phase is the stage of testing the design and evaluating the improvements obtained after the initial testing. The Support testing phase involves using the Cognitive Walkthrough method and the System Usability Scale questionnaire.

a. Effectiveness

The effectiveness result indicates how many respondents were able to complete the task scenarios performed in the tested application.

Table 7. Users' final results of effectiveness

Respondent Code	Successful Tasks	Total Task Scenarios	Percentage	Average Percentage
KR1	58	58	100	100%
KR2	58	58	100	
KR3	58	58	100	
KR4	58	58	100	
KR5	58	58	100	
KR6	58	58	100	
KR7	58	58	100	
KR8	58	58	100	
KR9	58	58	100	
KR10	58	58	100	

Table 7 shows the result of effectiveness based on user assessment. The results on the effectiveness aspect performed on each of the 58 tasks, and gave an average percentage of 100% as a result.

Similar results are also shown in the potential user's final result of effectiveness. These results can be seen in Table 8. Overall, the results on the effectiveness aspect gave successful results with an average percentage of 100%.

Table 8. Potential users' final results of effectiveness

Respondent Code	Successful Tasks	Total Task Scenarios	Percentage	Average Percentage
KR11	58	58	100	100%
KR12	58	58	100	
KR13	58	58	100	
KR14	58	58	100	
KR15	58	58	100	
KR16	58	58	100	
KR17	58	58	100	
KR18	58	58	100	
KR19	58	58	100	
KR20	58	58	100	

b. Efficiency

The efficiency result represents how quickly respondents were able to complete the task scenarios performed in the tested application.

Table 9. Users' final results of efficiency

Average Time	78.8 seconds
Successful Task Durations	4575 seconds
Total Task Duration	4575 seconds
Overall Relative Efficiency	100%

Table 10. Potential users' final results of efficiency

Average Time	105.4 seconds
Successful Task Durations	6114 seconds
Total Task Duration	6114 seconds
Overall Relative Efficiency	100%

The evaluation was performed to see the comparison between users and potential users in terms of efficiency in using the application. The average results generated by users as shown in Table 9 provide better results with less time than potential users shown in Table 10. However, both provide good results.

c. Usability Level

The usability level refers to the usability result obtained using the System Usability Scale method from respondents who have performed the task scenario tests.

Table 11. Results of usability level

Total Number of Respondent Scores	1778
Usability Level	88.9
Grades	A (Acceptable)

Table 11 is a processed data table from the results of testing using the SUS questionnaire against the application design prototype. The results show an increase when compared to the results of testing on the old application design. The score on usability level testing on the Taring application prototype shows good results, namely at 88.9 which is based on the SUS score category in Table 1, classified as category A (acceptable).

7. Comparison of Results

The analysis results of the Taring application will be compared with the testing results obtained from the prototype of the Taring application using the same respondents. The purpose of this comparison is to determine any changes in the outcomes obtained from the analysis and testing through the tested task scenarios.

a. Users

The effectiveness has increased from 97.41% to 100%, while Efficiency has increased from 96.7% with an average completion time of 129.4 seconds to 100% with an average completion time of 78.8 seconds.

Table 12. Users' comparison of result

Comparison	Effectiveness	Efficiency
Before	97.41%	96.7% (129.4 seconds)
After	100%	100% (78.8 seconds)

Table 12 shows that the aspect of user-perceived effectiveness has increased after implementing the new design. This proves that the new design can bring increased effectiveness for users in utilizing the website.

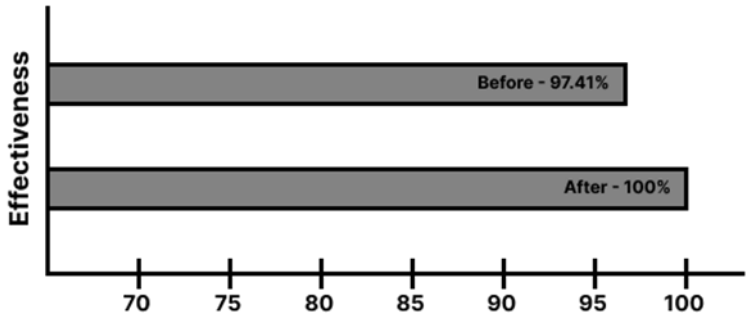

Figure 6. Graph of user effectiveness comparison

The comparison of the results before and after the implementation of the new design on the effectiveness aspect can be seen in Figure 6. The graph shows an increase in the effectiveness of using the website.

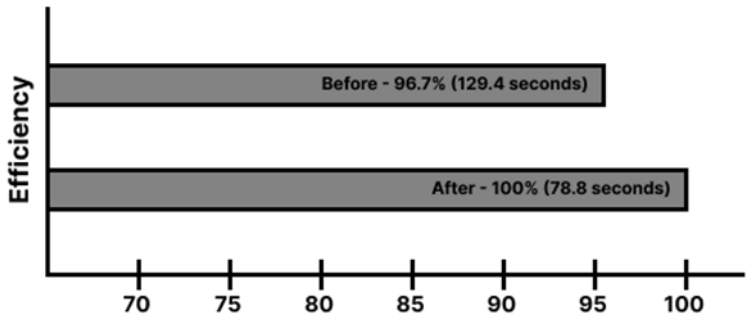

Figure 7. Graph of user efficiency comparison

Figure 7 shows a comparison of the results before and after the implementation of the new design in terms of efficiency. According to users, efficiency increases with the new design

b. Potential Users

The effectiveness has increased from 95% to 100%, and the efficiency has increased from 82.5% with an average completion time of 158.6 seconds to 100% with an average completion time of 105.4 seconds.

Furthermore, Table 13 shows the results of the efficiency and effectiveness aspects for potential users. The table shows an increase, especially in the efficiency aspect which increased from 85.5% to 100%.

Table 13. Potential Users' Comparison of Result

Comparison	Effectiveness	Efficiency
Before	95%	82.5% (158.6 seconds)
After	100%	100% (105.4 seconds)

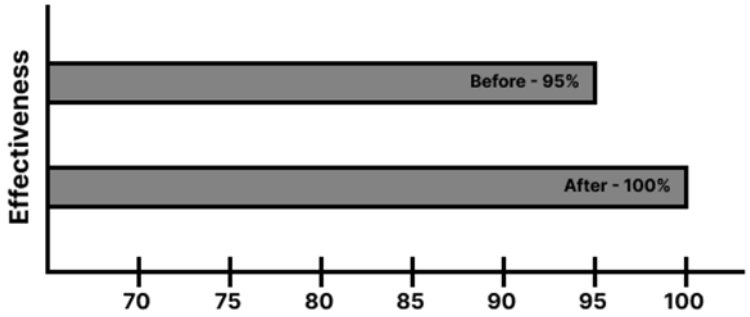

Figure 8. Graph of potential user effectiveness comparison

The graph of the effectiveness aspect for potential users is shown in Figure 8. The graph shows the difference between the results of the effectiveness assessment before and after the application of the design.

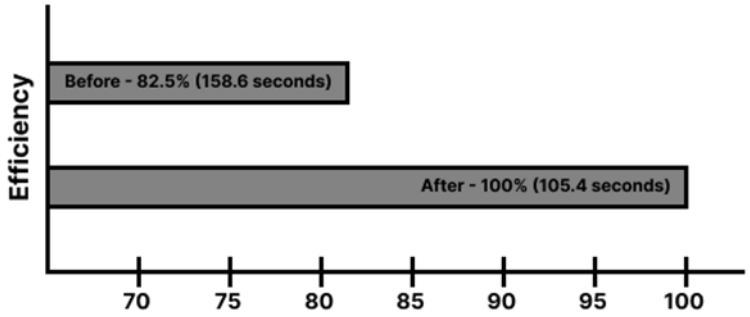

Figure 9. Graph of potential user efficiency comparison

Figure 9 shows a graph of the effectiveness aspect for potential users. The graph shows a significant increase in the effectiveness aspect of the new design.

c. Usability

In the overall System Usability Scale (SUS) score, there was an increase from 50.8 with a grade of E (not acceptable) in the analysis phase to 88.9 with a grade of A (acceptable) in the evaluation phase.

Table 14. Comparison of Usability

Comparison	Overall
Before	50.8 (E)
After	88.9 (A)

Table 14 shows the final results of the assessment of website usability. Based on the interpretation of the SUS score shown in Table 1, it shows that the usability of the website with the previous design gets a value of E (Not Acceptable). While usability after the application of the new design shows the value of A (Acceptable).

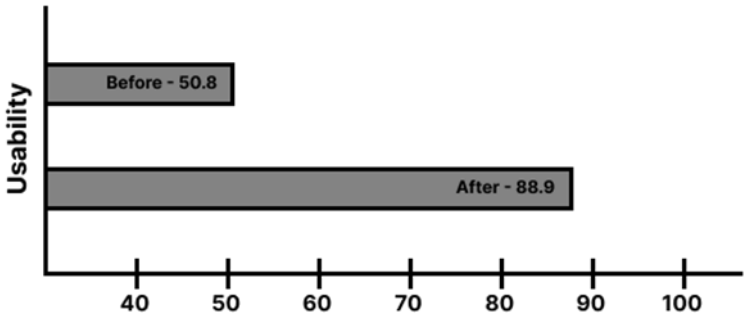

Figure 10. Graph of usability score comparison

Figure 10 shows a comparison graph of the usability assessment score results. The comparison graph of the assessment score results on the usability aspect shows a significant increase where the initial score shows a result of 50.8 and the score after the implementation of the new design gives a value of 88.9.

8. Improvement Recommendation

The design improvement solution is a summary of problems and input from respondents during the requirements and support stages. Research conducted previously by applying Goal-Directed Design provides solutions based on the problems found in the application [4]. This is also done in the evaluation process on this website, based on existing problems and input, an improvement solution is made, as follows.

Table 15. Improvement recommendations

No	Design Improvement Recommendation	Task Scenario	Stages
1	Add the list button on the main page	Task 1	Requirements
2	Combine and add the button feature 'Send OTP Code' on the registration page		
3	An additional feature of moving the forms for Foreigners to Indonesian Citizens is one button on the login page.	Task 2	
4	Add the validation page for users when submitting an application	Task 3-11	
5	Improvements in writing style and layout location of application requirements to be more comfortable to read		
6	Change the images in the application features using more relevant and consistent images.		
7	Improvement for the forms starts from the province first and fixes writing errors.	Task 12	
8	Change the 'Save' button to the 'Continue Application' button with the same function.		
9	Removing the 'Check Application' button on the application checking page and adding a 'Return' or 'Back' button.		
10	Improve the writing for the address after filling out the form to be more effective.		
11	Fix the queue write of the maximum quota/quota	Task 13	

	daily (500/0) to be daily quota/quota maximum (0/500). Added day details and removed holidays.		
12	Improve the appearance of the conditions page for a more comfortable view.		
13	Improve the queue details button to become easily visible.		
14	Move the 'Back' button to the top position so users can easily find the button to return.		
15	Add the 'change personal account data' feature on the profile page.	Task 14	
16	Add validation process when the user logs out.		
17	Improve the design of the footer so it will be more comfortable for users to see		
18	Add a view password feature when filling out the password form to make it easier for users to check the input password	Tasks 1,2, and 14	Support
19	Add revalidation when clicking the 'Back' button so that filling in the form is not wasted. Form is not wasted.	Task 12	
20	Addition of a page validation page after filling the form and an 'Edit Data' button button to make changes if there is an error form filling.		

The improvement recommendation shown in Table 15 is a summary of suggestions for implementing solutions to improve website design. There are several stages, namely requirements and support, where each stage has several design suggestions based on the scenario tasks carried out.

Conclusion

There is a total of 20 improvement recommendations were derived from the Goal-Directed Design and Cognitive Walkthrough methods. Out of the 20 improvement recommendations, 17 pertain to the requirement phase, while 3 pertain to the support phase. Effectiveness and Efficiency have increased, indicating that respondents were able to complete the given task scenarios without any obstacles.

The overall System Usability Scale score shows an increase from 50.8 with a grade of E (not acceptable) to 88.9 with a grade of A (acceptable). The comparison results indicate that the designed prototype has better usability than the Taring application because the prototype is designed based on the needs and solutions derived from the constraints experienced by the respondents.

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