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The Implementation of User Satisfaction Based Shortest Job First Algorithm Efficiency in Queuing System

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Abstract

Efficient and structured queue management is crucial to ensure the smooth operation of various services in both the public and private sectors. A web-based queue system has now become a good solution due to their ease of access and ability to manage queues in real-time. In this study, a web-based queue system is developed that implements the Shortest Job First (SJF) algorithm to optimize service sequences. The SJF algorithm prioritizes services with the shortest processing duration, which is expected to reduce user waiting time and to increase overall system effectiveness. This research is conducted in the university's Bureau of General Administration and Finance queue system as the research object. The software development method uses Agile with the Extreme Programming (XP) framework. The results of system testing using the Black Box testing method to evaluate application functionality show that all test cases are valid, indicating that the system operates according to the desired requirements. System performance analysis is conducted by 40 students using the User Experience Questionnaire (UEQ), resulting in benchmark scores in which 5 variables are above average, and 1 variable is below average. These results indicate that the queue system built using the SJF algorithm is feasible and effective for users.

Keywords : *Agile Extreme Programming (XP), Queuing System, Shortest Job First (SJF) algorithm, User Experience Questionnaire (UEQ) Analysis*

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1. INTRODUCTION

The development of Technology is something that is inevitable in today's human life. Every technological innovation that is created provides various positive benefits, convenience, and becomes a new way of carrying out human daily activities [1]. Various human activities that were previously carried out manually can now be carried out digitally. One of them is queuing in certain activities. Queuing is a situation that arises when the number of people who want to use a service exceeds the existing capacity. Individuals come at unexpected and irregular times, which causes them to have to wait for a certain period of time before they can be served [2].

The University has a Bureau of General Administration and Finance (BAUK) that serves various administrative and financial aspects that support campus operations. However, the queues that occur in BAUK services at the University are less than optimal because the queue system does not use queue numbers and the service is carried out based on arrival time or the First In First Out (FIFO) algorithm. This can certainly make students with a short process time have to wait longer if the student in front of them has a long process time.

Shortest Job First (SJF) is a scheduling algorithm that runs based on the process with the shortest execution time and makes the average waiting time also short, so that implementing this algorithm can make the queue system more optimal than the previous queue system [3][4]. This study implements the Non-Preemptive SJF Algorithm on the BAUK University Queue System. The queue system application will be built web-based which can be used by users to take queue numbers online and can be served based on the queue with the shortest service process sequence first for time efficiency. The system is then tested for performance based on user satisfaction which is measured using the User Experience Questionnaire (UEQ) tool.

UEQ is a tool or questionnaire used to assess user experience of a product or application system. By using UEQ, users can express their feelings, impressions, and attitudes when assessing the system. The method of collecting responses for UEQ in this study is carried out through an online questionnaire [5]. UEQ has 26 items divided into six scales/dimensions, namely Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation and Novelty [6].

In this study, a literature review is conducted by reviewing previous studies, including journals that discuss similar topics, namely regarding the

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queuing system. The first study was about the creation of a payment queuing system conducted by Fithria et al. in 2019, resulting in a student queuing system with a FIFO queuing model developed using computer technology to help students find out their queue numbers and information about the queue numbers being served [7]. Another study on the design of a queuing system at an amusement ride conducted by Sari et al. in 2022, resulted in a queuing system with the FIFO method using C++ which makes it easier for ticket buyers or customers, and allows for comprehensive reporting. The disadvantage of this queuing system is that the output is still via CLI (Command Line Interface), it has not been implemented into a GUI (Graphical User Interface) [8]. Research on the design of an online queuing system for outpatient visits conducted by Melyanti et al. in 2020, resulted in an online queuing system that is capable of performing several tasks such as taking queue numbers, providing doctor schedule information, and providing daily reports of patient visits [9].

The difference between this study and previous studies lies in the methods and algorithms applied. In this study, the writer uses the Shortest Job First Non-Preemptive algorithm which is still rarely used in queuing systems and using the Agile method with the Extreme Programming development framework and the UEQ Data Analysis Tool with descriptive statistical analysis to measure the system based on user satisfaction.

2. RESEARCH METHODS

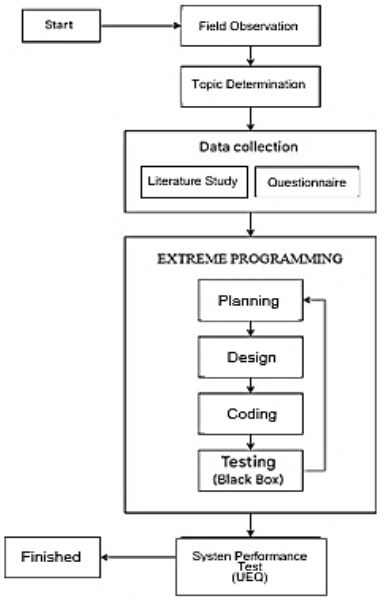

Figure 1. Research Flow

As stated in Figure 1, the research is conducted in several stages from beginning to end. Field observations are conducted through direct observation at the BAUK counter at the University regarding the ongoing queue process. Determination of the topic is based on the results of field observations, namely "Implementation of the Efficiency of the Shortest Job First Algorithm in the Queue System based on User Satisfaction". The process of collecting information data needed in the research is by conducting a literature study studying related journals and reference books.

2.1 Extreme Programming

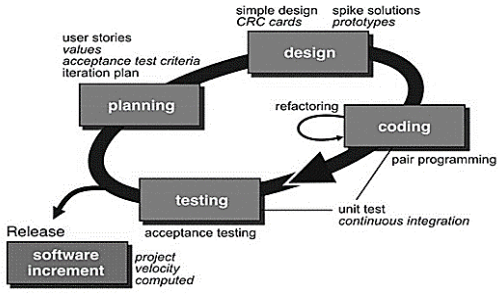

Figure 2. Extreme Programming

Extreme Programming (XP) is one of the frameworks in Agile Software Development that focuses on achieving the goals desired by developers without hindering development progress and without sacrificing software quality. The stages in the XP framework include Planning, Design, Coding, and Testing which are repeated until the development is considered complete by the user and ready to be launched [10][11][12].

2.1.1 Planning

The Planning stage is the first stage of system development where planning activities are carried out, namely identifying the system processes that are running until determining the specifications for the system. The functional requirements in this stage are that the system manages the queue based on the Shortest Job First Non-Preemptive algorithm rules specified in the following table.

Table 1. SJF Algorithm Rules to be applied

No	Queue Service Types	Execution time (minutes)
1.	Collecting the exam card	7
2.	Semester tuition payments	12

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No	Queue Service Types	Execution time (minutes)
3.	Payment of arrears	7
4.	Creation of dispensation letters	6

Table 1. is the relative execution time of queue services provided by BAUK officers, based on the results of a questionnaire that has been conducted by all actors participating in the system before the queue system is created.

2.1.2 Design

This Design stage is carried out system modelling activities and system interface design. System modelling consists of system functional modelling, system process modelling and database modelling. System modelling uses 3 Unified Modelling Language (UML) diagrams, namely Use Case Diagram, Activity Diagram and Class Diagram [13][14].

a. ***Use Case Diagram***

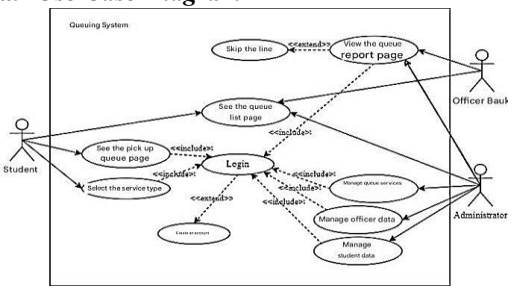
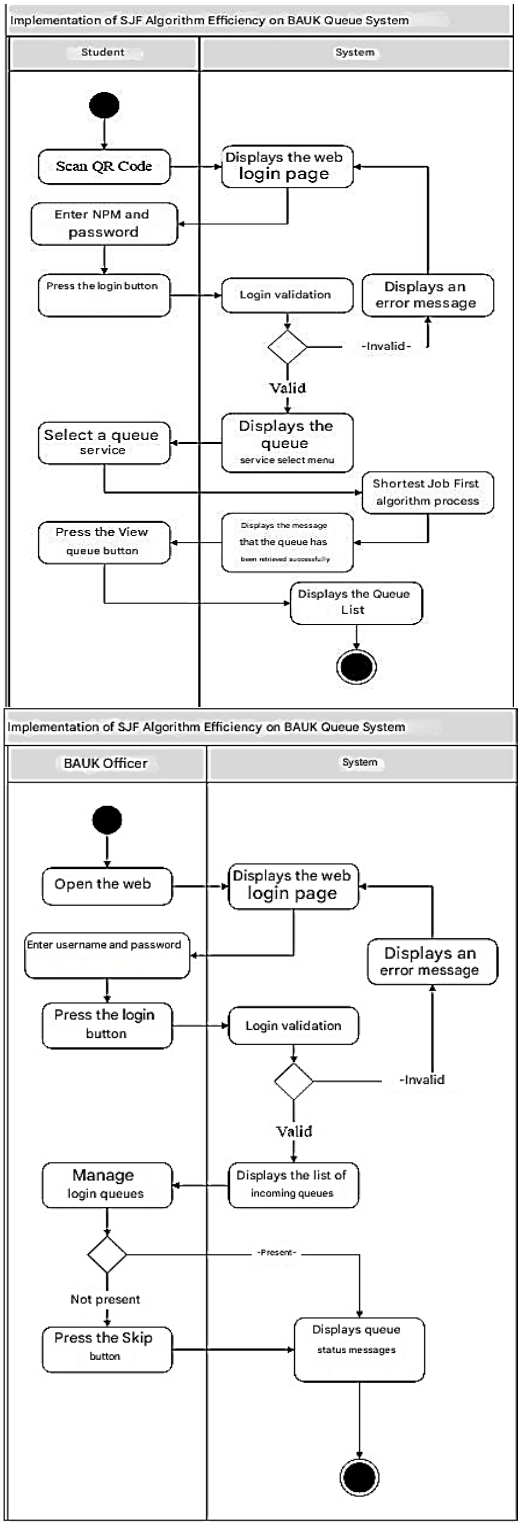


Figure 3. Use Case of Queue System

Figure 3 above is a Use Case that visualizes the relationship between actors and the queue system. There are 3 actors namely Students, BAUK Officers and Administrators.

b. ***Activity Diagram***



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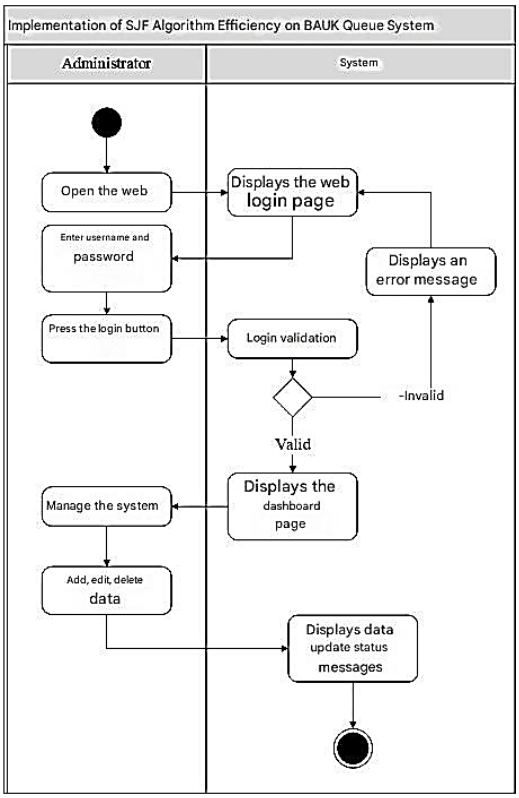

Figure 4. Activity Diagram of Queue System

Figure 4 is a visualization of the sequence of process activities or workflows carried out by students, officers and administrators with the system.

c. ***Class Diagram***

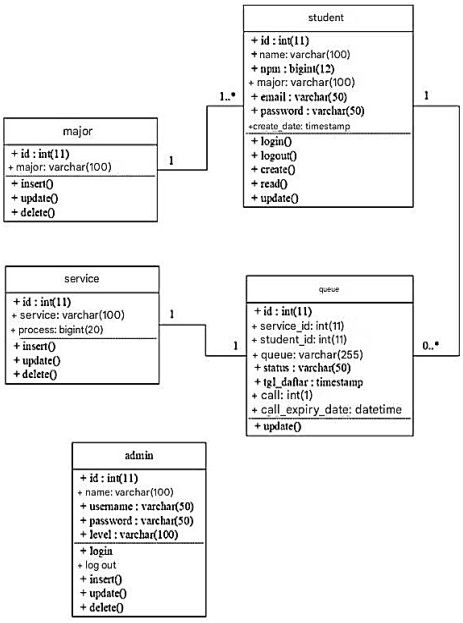

Figure 5. Class Diagram of Queue System

Figure 5 above is a class diagram that shows the classes, attributes, accessible methods and relationships between classes in the queue system that was built.

2.1.3 Coding

The Coding stage is the implementation stage of the model design that has been made into the form of an interface. System coding is built using PHP, MYSQL, and Visual Studio Code. Each system coding is used as a programming language, database management and code editor application.

2.1.4 Testing

Testing Phase or Testing uses Black Box to test the system that has been built by identifying the types of errors that occur during the application running and ensuring that the system is in accordance with its specifications. The method used in Black Box Testing is validation.

2.1.5 System Performance Test

This stage uses the UEQ tool by conducting descriptive statistical analysis. UEQ has 26 items divided into six dimensions which can be seen in the following figure [15][16].

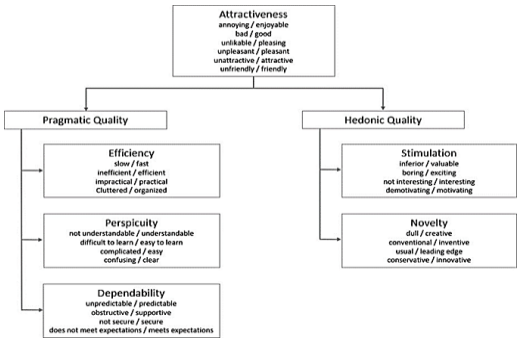

Figure 6. Assumed scale structure of the UEQ.

Each item in the Pragmatic and Hedonic Quality domains as shown in Figure 6 is represented by two terms with opposite meanings. Half of the items in the scale start with a positive value and the other half start with a negative value. The system performance test was conducted by 40 students and the respondents were collected through an online questionnaire using Google Form. The data results obtained from the questionnaire were then analyzed using the UEQ Data Analysis Tool version 12 system that has been built by identifying the types of errors that occur during application running and

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ensuring that the system is in accordance with its specifications. The method used in Black Box Testing is validation.

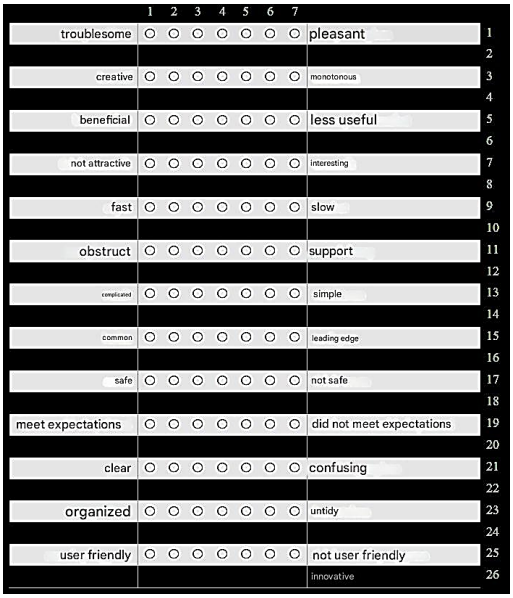

Figure 7. Version english of the UEQ

Based on Figure 7, respondents expressed their feelings while using the app by selecting a score between 1 to 7, which most closely approximates their experience while using the system.

3. RESEARCH RESULTS

3.1 System Interface Results

Figure 8. Website Page View

Figures 8, 9, 10 show the results of system coding using programming languages, database management and code editors, namely PHP, MYSQL and Visual Studio Code.

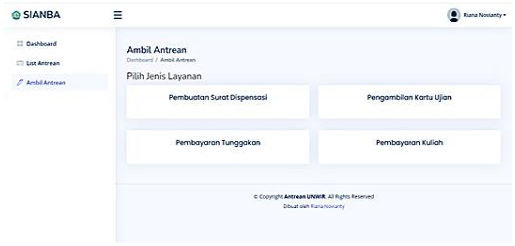

Figure 9. Take Queue Page View

Figure 10. Queue List Page View

Figures 8, 9, 10 show the results of system coding using programming languages, database management and code editors namely PHP, MYSQL and Visual Studio Code.

3.2 System Testing

Table 2. Black Box Testing Results

No	Testing	Nama Tes	Status
1.	Account Registration	Mendaftar akun	Valid
2.	Log in	Log in to the queue system page	Valid
3.	Queue List	View queue lists Search for queue lists Skip the queue	Valid Valid Valid
4.	Take Queue	Retrieve a queue Choose a queue service type View queues	Valid Valid Valid
5.	Log out	Exit the queue system page	Valid

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No	Testing	Nama Tes	Status
6.	History Antrean	View queue history	Valid
		Search for queue data	Valid
7.	Prodi Data	View the list of study programs	Valid
		Adding study programs	Valid
		Editing study programs	Valid
		Delete a study program	Valid
8.	Service Data	View queue services	Valid
		Add queue services	Valid
		Edit queue services	Valid
		Delete a queue service	Valid
9.	Officer's Data	View an officer's account	Valid
		Add an officer account	Valid
		Edit an officer account	Valid
		Delete an officer account	Valid
10.	Student Data	View student account data	Valid
		Add student account data	Valid
		Edit student account data	Valid
		Delete student account data	

4. DISCUSSION

4.1 UEQ System Test

The results of the data obtained were analyzed using the UEQ Data Analysis Tool version 12. The analysis uses the mean (average) value of each dimension item and questionnaire statement. The results of the data from the respondents' answers taken and have been calculated on average, grouped in each dimension, namely attractiveness, clarity, efficiency, accuracy, stimulation and novelty. Then it is calculated whether the respondents are satisfied or dissatisfied with the tested system based on the average range value <0.8 indicating a negative evaluation, -0.8 and 0.8 indicating a neutral evaluation and >0.8 indicating a positive evaluation. The following are the results of the average value of each dimension.

Item	Mean	Left	Right	Evaluation
1	1.3	troublesome	pleasant	Positive
12	1.9	Good	bad	Positive
14	1.0	disliked	encouraging	Positive
16	1.4	uncomfortable	comfortable	Positive
24	1.4	attractive	not attractive	Positive
25	1.7	user friendly	not user friendly	Positive

Figure 11. Dimensions of Attractiveness

The Appeal dimension measures the extent to which the user's general impression of the app's design and visual appearance. The analysis results listed in figure 11 above, show that all items from the attractiveness dimension received positive evaluations.

Item	Mean	Left	Right	Evaluation
2	1.4	incomprehensible	understandable	Positive
4	1.8	easy to learn	difficult to learn	Positive
13	1.7	complicated	simple	Positive
21	1.7	clear	confusing	Positive

Figure 12. Dimension of Perspicuity

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The Clarity dimension measures how well users understand the function and purpose of the application. The analysis results listed in Figure 12, show that all items in the clarity dimension received positive evaluations.

Item	Mean	Left	Right	Evaluation
9	1,2	fast	slow	Positive
20	1.3	not efficient	efficient	Positive
22	1.5	not practical	practical	Positive
23	1.4	organized	untidy	Positive

Figure 13. Dimension of Efficiency

The Efficiency dimension measures how far users feel that the application or system allows them to complete tasks quickly and effectively. The analysis results listed in Figure 13, show that all items in the efficiency dimension received positive evaluations.

Item	Mean	Left	Right	Evaluation
8	1.0	unpredictable	predictable	Positive
11	1.7	obstruct	support	Positive
17	1.5	safe	not safe	Positive
19	1.4	meet expectations	did not meet expectations	Positive

Figure 14. Dimension of Dependability

The Dependability dimension assesses how far the user feels that the app is reliable for troubleshooting a given problem or task. The results of the analysis listed in figure 14, show that all *items* in the accuracy dimension obtained a positive evaluation value.

Item	Mean	Left	Right	Evaluation
5	2.0	beneficial	less useful	Positive
6	0.6	boring	exciting	Neutral
7	1,2	not attractive	interesting	Positive
18	1.3	motivating	not motivating	Positive

Figure 15. Dimensions of Stimulation

The Stimulation dimension assesses how far an app or system provides an engaging and motivating experience for users. The results of the analysis listed in figure 15, show that *item* 6 obtained a neutral evaluation, while the other item in the stimulation dimension obtained a positive evaluation.

Item	Mean	Left	Right	Evaluation
3	0.6	creative	monotonous	Neutral
10	0.2	inventive	conventional	Neutral
15	0.5	common	leading edge	Neutral
26	1.4	conservative	innovative	Positive

Figure 16. Dimension of Novelty

The Novelty Dimension assesses how far the level of novelty and uniqueness of the features and functionality of a system or application is according to the user. The results of the analysis listed in figure 16, only item 26 produced a positive evaluation while other *items* from the novelty dimension produced a neutral evaluation.

4.2 UEQ System Calculation

The results of the UEQ calculation based on the grouping of aspects shown in figure 17, the Attractiveness aspect produces a value of 1.42 with a positive evaluation which means that the use of the system is attractive to users. Pragmatic Quality resulted in *a mean value* of 1.46 with a positive evaluation, which means that the system meets the needs and expectations of users in the context of functionality and practical usability. The quality of Hedonis resulted in a mean value of 0.96 with a positive evaluation which means that the system meets the emotional needs and personal aspirations of the user.

Pragmatic and Hedonic Quality	
Attractiveness	1.42
Pragmatic Quality	1.46
Hedonic Quality	0.96

Figure 17. UEQ Scale Based on Aspect Groups

Scale	Mean	Comparisson to benchmark	Interpretation
Daya tarik	1,42	Above average	25% of results better, 50% of results worse
Kejelasan	1,63	Above Average	25% of results better, 50% of results worse
Efisiensi	1,37	Above Average	25% of results better, 50% of results worse
Ketepatan	1,39	Above Average	25% of results better, 50% of results worse
Stimulasi	1,27	Above Average	25% of results better, 50% of results worse
Kebaruan	0,66	Below Average	50% of results better, 25% of results worse

Figure 18. Benchmark Scale Comparison

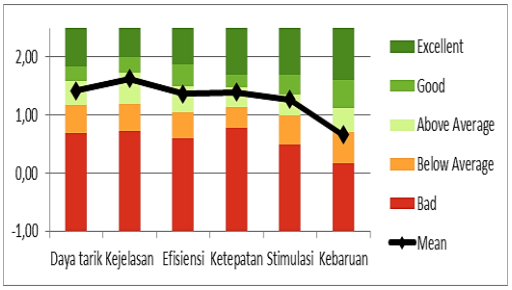

Figure 19. Benchmark Scale Graph

Figure 18 shows the results of the system performance test obtained a benchmark result of Above Average for a mean value of 1.42 in the dimension of attraction, 1.63 in clarity, 1.37 in efficiency, 1.39 in accuracy and 1.27 in stimulation with the interpretation of 25% of the results being better, while 50% of the results being worse. Meanwhile, the benchmark results

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of Below Average (below average) for the mean value of 0.66 in the novelty dimension with the interpretation of 50% of the results being better, while 25% of the results are worse. That way, based on UEQ analysis, it can be stated that the BAUK Queue System Website using the Shortest Job First algorithm is quite feasible and effective to be applied.

5. CONCLUSION

1. The queue system application using the *Shortest Job First Non-Preemptive* algorithm is able to provide an effective solution in managing service queues so that time becomes more efficient and prevents queue buildup or difficulty in queue taking. However, there are still shortcomings in the application of the *Shortest Job First algorithm* in the system.
2. System testing uses Black Box Testing to evaluate the functionality and output of the application regardless of its internal structure or source code, resulting in the valid status of each test case performed.
3. The analysis of the system performance test uses the User Experience Questionnaire (UEQ) descriptive statistical method, reviewed based on the responses of the respondents who had tested the system, resulted in a score of 1.42 on the Attractiveness dimension, 1.63 on Clarity, 1.37 on Efficiency, 1.39 on Accuracy, 1.27 on Stimulation and 0.66 on Novelty. Five dimensions obtained a benchmark value of Above Average and one dimension of Below Average. The mean value in the aspect of Attraction is 1.42, Pragmatic Quality was 1.46 and Hedonistic Quality was 0.96. So, from these results, the system can be declared quite feasible and effective to be used by users.

6. SUGGESTIONS

As an effort to improve the BAUK Queue System at the University in the future, it is recommended to:

1. The system needs to be repaired again by paying attention to the shortcomings and possible problems or *human errors* that occur so that it can cause the system to be less effective to use.
2. The system should be developed using Artificial Intelligence to make it more optimal and add other features to the system as needed that may change over time.
3. It is recommended to conduct a thorough *White Box* test of the system to ensure accurate system code and logic functionality, as well as to identify potential security vulnerabilities and hidden bugs that were not detected during *Black Box testing*.

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