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Qur'an tilawatil examination system: A group decision support system

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Abstract — Group Decision Support Systems (GDSS) are used when the decision-making system has multiple stakeholders making recommendations in the system. One of them is Tilawatil Al-Qur'an for students in the field of religious examination which consists of several appraisers. The purpose of this study was to optimize the results of the Simple Multi-Attribute Rating Technique (SMART) method using Borda in calculating the results of the Tilawatil Qur'an test based on a decision support system. The process is carried out by testing the sample results from several raters which are processed using the SMART method. Then it will be optimized by Borda. The initial process of the sample will be calculated manually, this process is carried out to compare the results of the sample calculation with the calculation of a website-based system. The results of the study were based on a manual SMART value accuracy test with a 95% yield system. After that, the results of the optimization test of the Borda method are calculated by calculating the average value of the SMART method with the optimal ranking results.

Keywords – borda, GDSS, SMART, tilawatil of the qur'an test

I. Introduction

The learning community today has an important role in raising the image of the campus, especially students at the Faculty of Science and Technology and in general the State Islamic University of North Sumatra. It should also be required to have advantages including the field of religion. These students must complete certain targets, such as memorizing 30 chapters and being fluent in Quran recitations. There is also an examination in the field of religion which is carried out before conducting an open trial, including assessing students' understanding of this field. However, there are some findings in the recitation of the Qur'an, in particular, there are still students who still have errors in reading and are not fluent in reading the Qur'an. The Qur'an is one of the most widely read and remembered holy books in the world. To make the recitation of the Qur'an beautiful, almost all the readers of the Qur'an around the world chant a certain melody which is called maqam in Arabic. However, due to limited resources, students find it more difficult to master this art than the Tajweed technique [1].

To solve the above problems, a recitation test system is needed before the open trial exam to measure student fluency in reading the Qur'an. Tilawatil test score results are calculated using the Simple Multi-Attribute

Rating Technique (SMART) method to determine if a student can pass the exam. The SMART method is a method used for multi-criteria decision-making developed by Edward in 1977. The SMART model has the advantage of emphasizing the more important attributes while reducing the value of the more important attributes when evaluating the utility of the overall solution [2]. The SMART method is based on an additional linear model. This means that the total score for a particular Choice is calculated by multiplying the total score for each criterion (attribute) by the criterion weight [3]. The SMART method can provide more accurate assessment results by giving weight to each criterion [4]. The SMART method has been used to organize and evaluate the activities of solving large and complex problems [5]. Because the assessment process has many criteria [6]. The theory is that each option has a set of criteria with a value, and each criterion has a weight that determines its importance relative to the other criteria [7]. SMART was used in the final cocoa bean selection process which is a combination of other methods [8].

In the decision system to be built, the SMART method process is carried out with several respondents or assessors of the recitation test. So it is necessary to optimize the results of the SMART method ranking of several respondents with the Borda method. Borda has been used to find the best candidates and has an advantage in random strategies [9]. Borda has also been used to combine preferences in many contexts [10] and this method is well-known in the voting system [11]–[13] or ranking-based collaborative filtering [14]-[16]. The Borda count ranking method is applied to the population and each individual is assigned a Borda score. The person with the lowest score is then removed from the population and replaced with a new solution [9]. The use of the Borda method has been carried out to support the discovery of aggressive and inhibitory properties in undergraduate children [17]. Borda Count has been used to select a node that is more in line with the wishes of a node on one of the Blockchain algorithms [18]. The Fuzzy Borda method is used to score a combination of different results from several assessment methods [19]. Borda's calculation algorithm was once performed on general multi-biometric retrieval in an optimized structure [20], as well as other research is used to optimize the problem of selecting functions in classification [21]. The risk of using radio waves is calculated using the Borda ordinal method. This indicates that this method allows a more accurate risk level assessment compared to the risk matrix method [22].

The purpose of this study is to create a group-based decision support system in evaluating the Tilawatir Quran test. In the system, there are two or more raters who will be processed by the system using the SMART method. Each rater's decision processed by the SMART method will then be optimized by the Borda method.

For a better understanding, we organized this paper as follows. In section II, we provide the research method and followed by the result in section III. Section IV presents the discussion. Finally, the conclusion is shown in section V.

II. Research Method

Research methodology is a research process that has four steps; namely, data collection, SMART method calculation, Borda method calculation, and testing. Fig. 1 illustrates the research methodology architecture.

A. Data Collection

Data collection is very important in a study. Conducted at the Faculty of Science and Technology by taking the data on the students' Tilawatil test scores (see Fig. 1). The faculty have majored in computer science, information systems, mathematics, biology, and physics.

From a total of 4168 students in 2021, five samples will be taken which will be calculated using the SMART and Borda methods. The sample was obtained from the results of recording the number of recordings made during data collection was 35 records. The limit of the number of juz and letters used depends on the examining jury in the field of religious testing. Participants will read according to the instructions in Tilawatil's five verses. The stages of this research are shown in Fig. 2, which can be seen from the processing of the test data to testing.

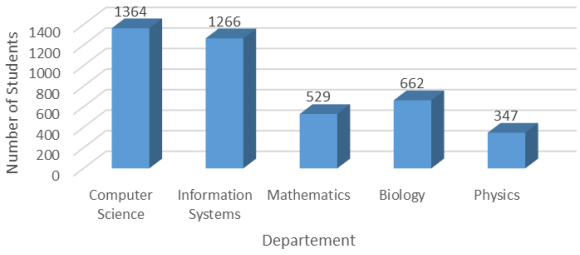

Fig. 1. Number of students of the Faculty of Science and Technology.

B. SMART Method Calculation

SMART method calculation comprises of scoring criteria, weight set, normalization, utility value, and final score.

1) Set of scoring criteria

The criteria are the determining factors in determining the alternative ranking results. Identify the criteria used in solving decision-making problems. We need data from competent stakeholders about the problem to be solved to determine the criteria used in this decision-making system [23]. The criteria are the results of interviews from Institute for Tilawatil Qur'an Development (LPTQ).

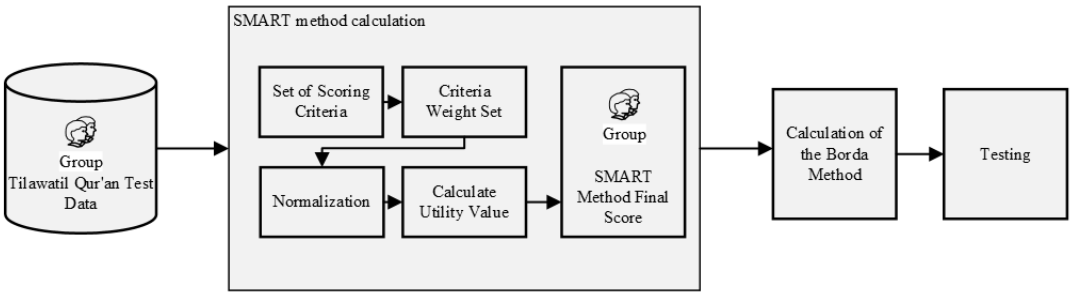

Fig. 2. Methodology architecture.

2) Criteria weight set

For each criterion with the most important data priority, the weight of each criterion uses an interval of 1-100 [24]. This study uses a criterion weight of 100 which comes from experts on the LPTQ.

3) Normalization

Calculate the normalization of each criterion weight by comparing the value of the weight of the criteria with the total weight of the criteria using (1) [25]:

$$w_i = \frac{w_i'}{\sum_{j=1}^{m} w_j} \tag{1}$$

where w_i is the normalized criterion weight for the i^{th} criterion, w_i' is the i^{th} criterion weight, and w_j is the j^{th} criterion weight, and $j = 1, 2, 3, \cdots, m$, is the number of criteria.

4) Calculate utility value

Determine the utility by converting each criterion value into a standard data criterion value [26]. The value of this utility depends on the nature of the criteria itself, it can be a cost or a benefit (see (2) and (3)).

$$u_i(a_i) = \frac{c_{\text{max}} - c_{\text{out}}}{c_{\text{max}} - c_{\text{min}}} 100\% \tag{2}$$

where $u_i(a_i)$ is the utility value of the i^{th} criterion for the i^{th} alternative, c_{max} is the maximum criterion value, c_{min} is the minimum criterion value, and c_{out} is the i^{th} criterion value. Cost criteria like this are usually in the form of costs that must be incurred or in other words these criteria are detrimental if they have a high value (*e.g.,* price criteria, criteria for using goods delivery rates, payback period in a business).

$$u_i(a_i) = \frac{c_{\text{out}} - c_{\text{min}}}{c_{\text{max}} - c_{\text{min}}} 100\% \tag{3}$$

the difference in the benefits equation in the value to be distributed where cout is reduced by cmax. Profit criteria like this are usually in the form of profits or in other words, if the criteria value is high, it will provide benefits (*e.g.,* hard disk capacity criteria, quality criteria and others).

5) SMART method final score

Verify the final value of each information by multiplying the value obtained from the normalized value of the standard information criteria by the normalized value of the criteria weight (see (4)).

$$u(a_i) = \sum_{j=1}^{m} w_j * u_j(a_i) \tag{4}$$

where $u(a_i)$ is the total value for the i^{th} alternative, w_j is the normalized weight value of the j^{th} criterion, and $u_j(a_i)$ is the j^{th} criterion utility value for the i^{th} alternative.

C. Calculation of the Borda Method

The stages of case resolution using the Borda method are as follows [27]:

1) Determine the ranking value in the order of alternative choices with the highest number of ranking points m, where m is the total number of alternatives.
2) The number m is used as a multiplier for the number of votes in the relevant data. Each decision maker assigns a value of $n-1$ for the first choice alternative, the value of $n-2$ for the second choice alternative, $\cdots$, and a value of 0 for the last choice alternative.
3) Calculation of the value of the Borda function from alternative choices, then the choice with the highest value is the choice that is most in demand by decision makers.

D. Testing

Continue to test system validation. Validation test consists of black box test for admin system, black box test for scoring system and black box test for judging criteria. Test the accuracy of manual assessment with the system and the last test is the average value with the Borda method.

III. Result

The result of the experiment comprises of Quran tilawatil test sample data, criteria and weight, normalization, utility value, and calculating SMART method final score, calculating borda method, proposed decision support system, and testing.

Table 1. Data on the Results of the Qur'an Tilawatil Test According on Appraiser 1 (Appr. 1) and Appraiser 2 (Appr. 2)

No.	Participant	Fashah Value		Tajweed Value		Voice Value		Song Value	
		Appr. 1	Appr. 2	Appr. 1	Appr. 2	Appr. 1	Appr. 2	Appr. 1	Appr. 2
1.	Dewi Kartika	Appropriate	Not exactly	Dominate	Not mastering	Well	Not good	Well	Not good
2.	Anggraeni	Very incorrect	Not exactly	Very uncontrollable	Not mastering	Well	Not good	Well	Very not good
3.	Dedyka Syahputra	Very incorrect	Not exactly	Very uncontrollable	Not mastering	Well	Well	Very not good	Well
4.	Adam Syahputra	Not exactly	Not exactly	Not mastering	Very uncontrollable	Not good	Not very good	Not good	Not good
5.	Diana Asmarani Siregar	Very incorrect	Very incorrect	Dominate	Not mastering	Well	Not good	Not good	Not good

A. Quran Tilawatil Test Sample Data

The method of collecting is by recording the readings in audio format. The audio format will be assessed by an evaluator consisting of two raters (see Table 1). And can test directly on the appraiser.

B. Criteria and Weights

There is a weight for each criterion. The weights are obtained from the priority of the assessment (see Table 2). In addition to the criteria there are sub-criteria, this is the value of each criterion from alternative data whose data is quantitative (see Table 3).

Table 2. Criteria for Assessment of Al-Qur'an Tilawatil Examination

No	Code	Criteria	Weight
1	K1	Fashah	30
2	K2	Tajweed	35
3	K3	Voice	20
4	K4	Song	25

From the results of the interview, the highest weight on the Tajwid criteria and so on if added up is 100.

Table 3. Sub-criteria

No	Criteria	Sub-criteria	Value
1	Fashah	Very precise	85
		Appropriate	65
		Not exactly	45
		Very Incorrect	25
2	Tajweed	Very precise	85
		Appropriate	65
		Not exactly	45
		Very Incorrect	25
3	Voice	Very precise	85
		Appropriate	65
		Not exactly	45
		Very Incorrect	25
4	Song	Very precise	85
		Appropriate	65
		Not exactly	45
		Very Incorrect	25

There is a value in each sub-criteria which is a change from quantitative data to qualitative data. The distance value is determined based on the results of the interview.

C. Normalization

From section II-C, normalization is calculated using (1), and the results are shown in Table 4. For example, when w_i' = 30, thus, $w_i = 30/110 = 0.27$, and so on.

Table 4. Criteria Normalization Results

Code	Criteria	Weight	Normalization
K1	Fashah	30	0,27
K2	Tajweed	35	0,32
K3	Voice	20	0,18
K4	Song	25	0,23

D. Utility Value

The utility value is calculated by the benefit equation following the results of the two raters. The calculation of the utility value first changes the value data in the form of words, then it is converted into a numeric value according to the sub-criteria value (see Table 5).

Table 5. Changes in Participant Value on Appraiser 1

Code	Participant	K1	K2	K3	K4
P1	Dewi Kartika	65	65	65	65
P2	Anggreini	25	25	65	45
P3	Dedyka Syahputra	25	25	65	25
P4	Adam Syahputra	45	45	45	45
P5	Diana Asmarani Siregar	25	65	65	65

From this change it can be seen that the maximum and minimum values will then be determined.

Table 6. Minimum and Maximum Value of Appraiser 1

Value Category	K1	K2	K3	K4
Minimum Value	25	25	45	25
Maximum Value	65	65	65	65

Furthermore, it can calculate the utility value $u_{\text{Dewi}}(a_{\text{Fashoh}}) = \frac{65-25}{65-25} \times 100 = 100$ and so will the next calculation (see Table 7).

Table 7. Results of Appraiser Utility Value 1

Participant	K1	K2	K3	K4
P1	100	100	100	100
P2	0	0	100	50
P3	0	0	100	0
P4	50	50	0	50
P5	0	100	100	100

The order of calculation of Appraiser 2 is the same as that of Appraiser 1 but the results obtained are different. Starting from the change in value (see Table 8), the utility value (see Table 9), determines for the minimum and maximum (see Table 10).

E. Calculating SMART Method Final Score

The final grade will yield two results from two raters. At rater 1 can be calculated by multiplying the normalized weight value $u_{\text{Dewi}}(a_{\text{Fashoh}}) = 0.27 \times 100 =$

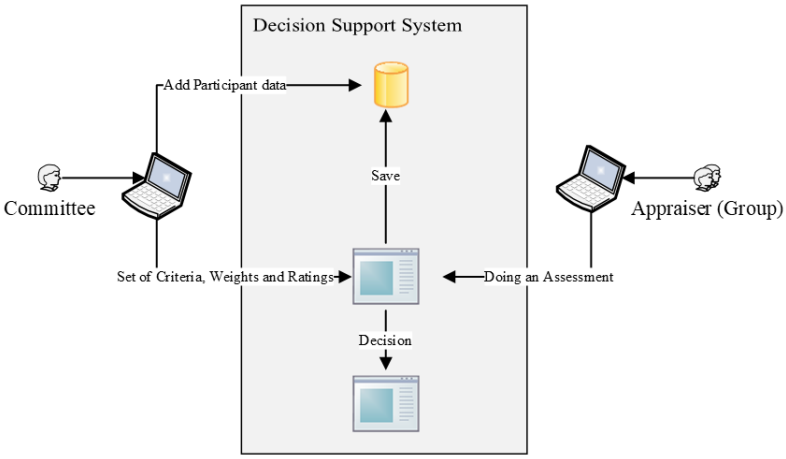

Fig. 3. Proposed system.

Table 8. Changes in Participant Values in Appraiser 2

Participant	K1	K2	K3	K4
P1	45	45	45	45
P2	45	45	45	25
P3	45	45	65	65
P4	45	25	45	45
P5	45	45	45	45

Table 9. Minimum and Maximum Value of Appraiser 2

Value Category	K1	K2	K3	K4
Minimum Value	25	25	45	25
Maximum Value	45	45	65	65

27 as well as the next calculation with the results can be seen in Table 11. To find the final value of the SMART method by adding up all the criteria values (see Table 12).

From the final results, Appraiser 1 in order of value is Dewi Kartika, Diana Asmarani Siregar, Adam Syaputra, Anggreini and finally Dedyka Syaputra. While the final results for Appraiser 2 were in the order of Dedyka Syahputra, Dewi Kartika, Anggreini, Diana Asmarani Siregar, and lastly Adam Syahputra. This sequence difference makes the first order decision not optimal. So optimized with the Borda method.

Table 10. Results of Appraiser Utility Value 2

Participant	K1	K2	K3	K4
P1	100	100	0	50
P2	100	100	0	0
P3	100	100	100	100
P4	100	0	0	50
P5	0	100	0	50

Table 11. Results of the Appraiser's Final Score 1 & 2

Appraiser	Parcitipant	K1	K2	K3	K4
1	P1	27	32	18	23
	P2	0	0	18	11,5
	P3	0	0	18	0
	P4	13,5	16	0	11,5
	P5	0	32	18	23
2	P1	27	32	0	11,5
	P2	27	32	0	0
	P3	27	32	18	23
	P4	27	0	0	11,5
	P5	0	32	0	11,5

F. Calculating of the Borda Method

The sum of SMART scores with BORDA Points with Tournament Style with the highest ranking gets the largest score with a total of n, the next rank will get a score of $n-1$, $n-2$ and so on (see Table 13). To get the results of the Borda method by adding up each rater after being multiplied by the Borda point (see Table 14).

G. Proposed Decision Support System

The proposed system is built based on the website, Fig. 3 illustrates the proposed system. The final result of the SMART method on the system is on behalf of Dewi Sartika on Appraiser 1 (see Fig. 4) and Dedyka Syahputra on Appraiser 2 (see Fig. 5). The system will also calculate the Borda method so that the best order of the two assessments can be found (see Fig. 6).

H. Testing

The test is carried out with a black box test consisting of the Committee system blackbox test (see Table 15), the Appraiser blackbox test (see Table 16). In addition to the black box test, the SMART method accuracy test was also carried out. Appraiser 1 is overall very good because the accuracy value is $> 95\%$ (see Table 17) and Appraiser 2 (see Table 18). The last test is to compare the average value of the SMART method with the calculation of the Borda method (see Fig. 7).

IV. Discussion

The SMART method is used to determine the best alternative. The application of this method in a web-based system can be done to make it easier to make decisions, one of which is by giving a decision on the results of the Tilawatil Qur'an test. In a previous study with the same case, learning Tajweed using the Multi-Objective Optimization On Basis Ratio Analysis (MOORA) method was used in the assessment of the Musabaqah Tilawatil Quran (MTQ) competition [28]. Furthermore, a similar case has been carried out but using the Analytical Hierarchy Process (AHP) method

Table 12. Rating Results of Appraisers 1 & 2

Appraiser	Participant ranking	K1	K2	K3	K4	SMART value
1	P1	27	32	18	23	100
	P5	0	32	18	23	72
	P4	13,5	16	0	11,5	41
	P2	0	0	18	11,5	29,5
	P3	0	0	18	0	18
2	P3	27	32	18	23	100
	P1	27	32	0	11,5	70,5
	P2	27	32	0	0	59
	P5	0	32	0	11,5	43,5
	P4	27	0	0	11,5	38,5

SMART Value

Participants	K1 FASHAHAH	K2 TAJWID	K3 SUARA	K4 LAGU	SMART Value
Dewi Kartika	2.72727	3.18182	1.81818	2.27273	100.00
Anggreini	0	0	1.81818	1.136365	29.55
Dedyka Syahputra	0	0	1.81818	0	18.18
Adam Syahputra	1.363635	1.59091	0	1.136365	40.91
Diana Asmarani Siregar	0	3.18182	1.81818	2.27273	72.73

Fig. 4. The final result of the SMART method of Appraiser 1 on the website system.

SMART Value

Participants	K1 FASHAHAH	K2 TAJWID	K3 SUARA	K4 LAGU	SMART Value
Dewi Kartika	2.72727	3.18182	0	1.136365	70.45
Anggreini	2.72727	3.18182	0	0	59.09
Dedyka Syahputra	2.72727	3.18182	1.81818	2.27273	100.00
Adam Syahputra	2.72727	0	0	1.136365	38.64
Diana Asmarani Siregar	0	3.18182	0	1.136365	43.18

Fig. 5. The final result of the SMART method of Appraiser 2 on the website system.

RANKINGS	PARTICIPANTS	*LAST UPDATED*	TOTAL POINTS
1	Dewi Kartika	*2 Weeks Ago*	781.82
2	Dedyka Syahputra	*2 Weeks Ago*	518.18
3	Diana Asmarani Siregar	*2 Weeks Ago*	377.27
4	Anggreini	*2 Weeks Ago*	236.36
5	Adam Syahputra	*2 Weeks Ago*	161.37

Fig. 6. The results of the calculation of the Borda method based on the system.

Table 13. Results of the Appraiser's Borda Points 1 & 2

Appraiser	Participant	SMART value	Borda Points	Total
1	P1	100	5	500
	P5	72	4	288
	P4	41	3	205
	P2	29,5	2	59
	P3	18	1	18
2	P3	100	5	500
	P1	70,5	4	280
	P2	59	3	177
	P5	43,5	2	87
	P4	38,5	1	38,5

Table 14. The results of the sum of the two raters on Borda points

Rating	Participant	Appraiser 1	Appraiser 2	Total Points
1	P1	500	280	780
2	P3	18	500	518
3	P5	288	87	375
4	P2	59	177	236
5	P4	205	38,5	243,5

with the same criteria used. However, the difference is seen in the ranking results which do not include the results of all raters [29]. Other techniques such as the Multi-Attribute Utility Theory (MAUT) method [30] and The Additive Ratio Assessment (ARAS) in the recommendation for selecting MTQ participants in the final ranking on the technique does not show how the results are correlated if there is more than one rater [31]. While in reality, the assessment for rote tests and the like at the national level has more than one appraiser. Therefore, the most important thing that can be seen from the results of the research above is the comparison in this study, there is an optimization done because more than one appraiser is used so it is a group decision support system. Optimization of several raters was carried out using the Borda method. In this study, there is also an accuracy test which is a comparison of manual calculation tests with system tests used so that the system can be used by stakeholders in the future.

V. Conclusion

Based on the system validation test results, the SMART method accuracy test in a system and manual calculations, as well as the Borda method comparison test with the average calculation of the two results (appraiser). First the admin system validation test, then the appraiser validation test, and the appraiser criteria validation test on the system. The results of the validation test indicate that the validation test is appropriate. In testing the accuracy between manual calculations and the system, very good results were obtained with an error accuracy value of more than 95%.

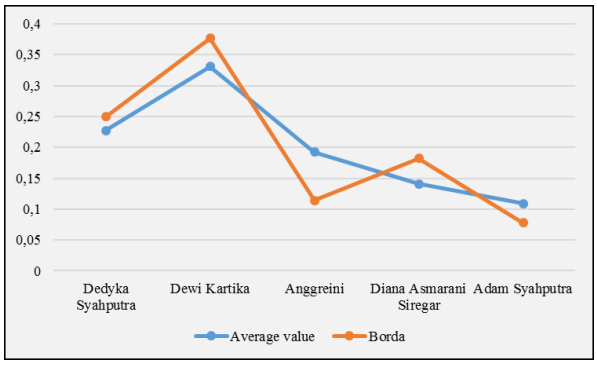

Fig. 7. Comparison of the average scores of the two appraisers using the BORDA method.

In the comparison test of the average value with the Borda method, there are differences in the order of magnitude of the values obtained. This happens because the Borda method optimizes the highest order value according to the order of each evaluator. Overall, the use of the Borda method in optimizing the results of the SMART assessment where there is more than one recommendation or rating can be optimized properly by generating rating recommendations.

The value of the SMART method produces the highest order value maximally because the SMART method will compare the values of the best alternatives even though the actual value is not maximal. This method can only be used if we only want to find the best order of each alternative. meanwhile, in the Borda method, the highest order value will be multiplied by a high value so that the first order value will have a very high value while the last order will have the lowest value. The Borda method can also be used if it will only look for the best order from several respondents.

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Table 15. Black Box Test Committee System

Application Name : Qur'an Tilawatil Exam Decision Support System Using SMART and BORDA Methods				Test Date: 24 September 2022 Validator Yustria Handika Siregar, M. Kom	
No	**Tested Pages**	**Actor Action**	**System Reaction**		**Results**
			True	**False**	
1.	Login Page	Click the "Sign In" button	Login On Page	Not logged on page	As Expected (Valid)
2.	User Manage Menu	Add, remove and edit users	Users can be added, deleted and edited	User failed to add, delete and edit	As Expected (Valid)
3.	Participant Data Menu	Add, delete and edit participant data	Participant data can be added, deleted and edited	Participant data failed to add, delete and edit	As Expected (Valid)
4.	Criteria Menu	Add, remove and edit criteria	Criteria can be added, deleted and edited	Criteria failed to add, delete and edit	As Expected (Valid)
5.	Sub-Criteria Menu	Add, remove and edit sub criteria	Sub criteria can be added, deleted and edited	Sub criteria failed to be added, deleted and edited	As Expected (Valid)
6.	Period Menu	Add, remove and active Period	Periods can be added, deleted and activated	Failed period added, deleted and activated	As Expected (Valid)
7.	Rating Set Menu	Add scoring set	Rating set can be added	The scoring set failed to add	As Expected (Valid)
8.	Menu Report	Print report	Reports can be printed	Report failed to print	As Expected (Valid)

Table 16. Black Box Assessment System Test

Application Name: Qur'an Tilawatil Exam Decision Support System Using SMART and BORDA Methods				Test Date: 24 September 2022 Validator Adi Widarma, S.Si., M.Kom.	
No	**Tested Pages**	**Actor Action**	**System Reaction**		**Results**
			True	**False**	
1.	Login Page	Click the "Sign In" button	Login On Page	Not logged on page	As Expected (Valid)
3.	Menu My Profile	Edit profile	Profile can be edited	Profile failed to edit	As Expected (Valid)
4.	Participant Data Menu	Add, delete and edit participant data	Participant data can be added, deleted and edited	Participant data failed to add, delete and edit	As Expected (Valid)
5.	Rating Menu	Participant Rating	Participants were successfully assessed	Participants fail to be assessed	As Expected (Valid)
5.	Sub-Criteria Menu	Add, remove and edit sub criteria	Sub criteria can be added, deleted and edited	Sub criteria failed to be added, deleted and edited	As Expected (Valid)

Table 17. Manual SMART Method Accuracy Test and Appraiser System 1

Participant	**Manual**	**Sistem**	**Error**	**Error (%)**
Dewi Kartika	100	100	0	0
Diana Asmarani Siregar	72	72,73	0,73	1,01
Adam Syahputra	41	40,91	0,91	2,22
Anggreini	29,5	29,55	0,55	1,86
Dedyka Syahputra	18	18,18	0,18	1
Total Error %				6,09
Average Error %				1,22
Accuracy (100%-Average Error %)				98,78

Table 18. Manual SMART Method Accuracy Test and Rating System 2

Participant	**Manual**	**Sistem**	**Error**	**Error (%)**
Dedyka Syahputra	100	100	0	0
Dewi Kartika	70,5	70,45	0,05	0,07
Anggreini	59	59,09	0,09	0,15
Diana Asmarani Siregar	43,5	43,18	0,32	0,74
Adam Syahputra	38,5	38,64	0,14	0,36
Total Error %				1,32
Average Error %				0,26
Accuracy (100%-Average Error %)				99,74

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