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Design and Development of Animal Recognition Application Using Gamification and Sattolo Shuffle Algorithm on Android Platform

Case Study: Kebun Binatang Ragunan

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***Abstract*—Information and communication technology has been developed rapidly and affected various aspects such as propagation of information and marketing strategy of tourist attraction. Kebun Binatang Ragunan is one of tourist attraction in Indonesia. Aside from recreation area, Kebun Binatang Ragunan can be a place to learn animals. However, learning animals itself tends to be less attractive and less interactive. Therefore, an application was developed as one of animal learning media to increase tourist motivation. The application developed in form of quiz game by using gamification like achievement to increase their motivation in animals learning and using Sattolo Shuffle algorithm in order to make quiz more varied. After testing, the application is known affect the Behavioral Intention to Use level around 76.96% and Immersion level around 82.43% in giving motivation and attracting tourist attention to use the application. Sattolo Shuffle algorithm successfully applied in application to produce a unique sequence of each randomized quiz.**

***Keywords*—Achievement, Animal Recognition, Gamification, Quiz Game, Sattolo Shuffle.**

I. INTRODUCTION

Information and communication technologies have an important role in propagating informations and modification in business strategies of tourism industry [1]. Tourism is an activities for recreation purpose, personal development, or to learn about uniqueness of tourist attraction that visited within a certain period [2]. One of the tourist attraction in Indonesia is Kebun Binatang, located in South Jakarta.

Gamification is one of the example of method that can attract users to have a different experience when visiting a tourist attraction [3]. Gamification is the use of game mechanisms and elements into non-game contexts [4]. Example of elements in gamification such as challenges, points, leaderboard, levels, badges, onboarding, and social engagement loops. Based of research that conducted by [5], the use of gamification in tourism can attract tourist when visiting an attraction, as well as improve experience and motivation in looking for informations at the tourist attraction.

Sattolo Shuffle algorithm is an algorithm for generating a randomized cyclic permutation that can give an unique result of randomness [6]. This algorithm is a modification from Fisher-Yates Shuffle algorithm.

In this research, an animal recognition quiz application with gamification methods and Sattolo Shuffle algorihm on Android platform to increase visitor's motivation to access informations about animals in Kebun Binatang Ragunan.

II. LITERATURE REVIEW

A. Gamification

Gamification as a concept has some meaning from some experts as follows.

1. Gamification is the use of game design elements from game into a non-game context [4].
2. Gamification is the application of game-thinking and game mechanisms of the game to engage users in solving daily problems [7].
3. Gamification is the use of game mechanisms, aesthetic values, and thinking patterns to motivate action, learning, and problem solving on people who participate in it [8].
4. Gamification is a process combining something that already exist with game mechanisms that can

motivate users in taking actions that can yield result to a business [9].

Based on some of these meaning, we can draw conclusion that gamification is a use of game models, mechanisms, elements, and thinking patterns into non-game context in order to motivate users to perform actions such as learning and problem solving. Some of the gamification features according to [7] are points, levels, leaderboards, badges, onboarding (tutorial), challenges, and social engagement loops.

B. *Sattolo Shuffle Algorithm*

According [10], Sattolo Shuffle algorithm is an algorithm for generating a randomized cyclic permutation from finite sequence. This algorithm is the result of modification of Fisher-Yates Shuffle, which generate non-biased permutation, like Sattolo Shuffle. Sattolo shuffle has several advantages such as simple concept and randomization of a permutation performed in same array so it can save the use of resources. The steps of Sattolo Shuffle algorithm are summarized from the study of [6] and [10] as follows.

1. Specify the length of the array which will be randomized.
2. Take the length of array into variable i.
3. Select a random number r between 0 and (i-1). This number will be array's index pointer.
4. Swap the array element of r with array element of (i-1).
5. Reduce the variable i by 1 and check whether i is greater than 1. If correct, repeat the third step until the variable i is equal to 1.

C. *Hedonic-Motivation System Adoption Model*

Hedonic-Motivation System Adoption Model (HMSAM) is a measurement model of a system that adapts from Hedonic-Motivation System (HMS). HMS is a system used to fulfillment intrinsic elements of users motivation based on hedonic characteristic [11]. There are five HMSAM measurement factors: *Perceived Usefulness* (to measure the performance of a system), *Perceived Ease of Use* (to measure the ease of use of system usage), *Curiosity* (to measure of cognitive level in curiosity), *Control* (perception as if users directly interact with system) and *Joy* (pleasure gained from interaction between users and system) that may affect *Behavioral Intention to Use* and *Immersion* of an application.

D. *Usability Measurement*

According to [12], *usability* is derived from *usable* which means it can be used well. [12] also reveals several notions of *usability* as follows.

- According to [13], *usability* is a branch of Human Computer Interaction that learn how to design interface in an information system application for convenient use by users
- According to [14], something that can be said to be useful if errors can be eliminated or minimized and gives benefit and satisfaction to the users.
- According to [15], *usability* refers to how users can learn and use the product to obtain their goals and how satisfied they are with the product
- According to [16], *usability* is the extent of a product can be used by users to achieve a target that set by effectiveness, efficiency, and satisfaction of product usage in a context such as product usage, tasks, and equipments.

Based on these definition, *usability* can be measured based on several components:

- *Learnability* defined how fast users adept in using the system as well as the ease of use of using a system function and what the users want.
- *Efficiency* defined as the resources spent in order to achieve accuracy and objective.
- *Memorability* defined how the user's ability to retain knowledge after a certain period, the ability to remember the menu layout always fixed.
- *Errors* is defined what mistakes that user make, including incompability of what user think with what actually represented by system.
- *Satisfaction* is defined as freedom from inconvenience, and a positive attitide towards the product usage as the user feels about the system.

E. *Qualitative Research Methods, Survey, Likert Scale*

Based on [17] research, qualitative research methods can be interpreted as a form of method that based on postpositivism or interpretive philosophy, that used to examine natural objects with qualitative research results emphasize more in meaning. [17] also stated that qualitative research methods suitable for random sampling data, collecting data based on research instruments, as well as statistical data analysis for hypothesis testing that has been established.

Survey, according to [18] is one of research method that examines large and small population and examines samples drawn from a population to find relative, distributive, and linked events between sociological variables and psychological variables.

Likert scale is a method that can be used to interpret qualitative result into statistical data. Data analysis with qualitative research method is statistical. Therefore, Likert scale is suitable for use along with qualitative research methods that process qualitative data into statistical data to ease in draw conclusions

[19]. Likert scale has a set of choice that contain statements that represent a value. The Likert scale set must be symmetric and balanced with range of choice from negative to positive choice [20], along with certain score that generate certain values in case be used for data processing [21].

III. METHODOLOGY

A. Application Design

The focus of this research is to make an application contains questions of animal information in Kebun Binatang Ragunan. This application name is Ragunan Zoo Quiz which is built based on Android with Ice Cream Sandwich OS as minimum OS .

Ragunan Zoo Quiz created based on the following gamification elements.

- *Challenges* are used in form of quiz. The quiz based from information of animals that written on the information board in each of animal cage.
- *Onboarding* are used in form of tutorials that explain how to use the application from the beginning.
- *Levels* are used in form of division of Kebun Binatang Ragunan by five areas. The division of areas based on the number of animal species found in each area. Total samples of animal species taken as many as 50 samples with 12 species in Area 1, 11 species in Area 2, 10 species in Area 3, 4 species in Area 4, and 13 species in Area 5.
- *Achievements* using Google Play Games Achievement with 17 achievements. Beside *achievement*, there are also *experience point* that can be obtained after opening an *achievement*. *Experience point* based on quiz area.

TABLE I. ACHIEVEMENTS AND EXPERIENCE POINTS

Achievement Name	Experience Points
First Time Using Ragunan Zoo Quiz	1000
First Time Game Over	500
First Time in Area 1	1500
First Time in Area 2	1500
First Time in Area 3	100
First Time in Area 4	500
First Time in Area 5	2000
Complete the Area 1	2000
Complete the Area 2	2000
Complete the Area 3	1500
Complete the Area 4	1000
Complete the Area 5	3000
Master of Area 1	3000
Master of Area 2	3000
Master of Area 3	2000
Master of Area 4	1500
Master of Area 5	5000

The more types of animals in one area, the greater the *experience point* gained.

- *Points* are used to calculate the correct or wrong answers and the Chance number they have. The result will be used to open the *achievement*.
- *Leaderboard* using Google Play Games Leaderboard to show *points* that users get after completing the quiz.
- *Social engagement loops* are used in the form of sharing user's point in Twitter.

B. System Design

B.1. Data Flow Diagram

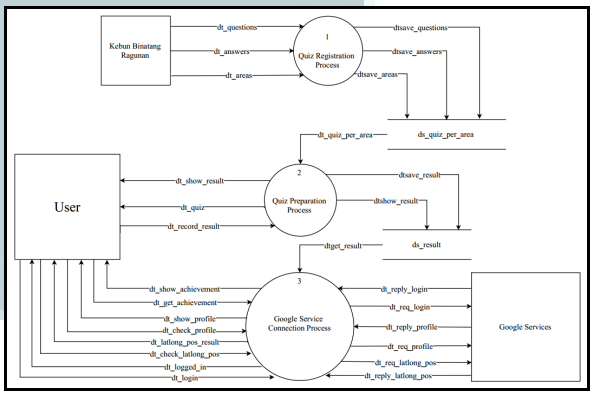

Fig. 1. DFD Level 1

Fig. 1 shows DFD Level 1 of the Ragunan Zoo Quiz system. There are three processes and three entities in the diagram. Three processes include the Quiz Registration Process, Quiz Preparation Process, and Google Service Connection Process. Three existing entities include User, Kebun Binatang Ragunan, and Google Services.

Quiz Registration Process serves to store quiz data and answers on a storage. Quiz Registration Process retrieves data from animal information in Kebun Binatang Ragunan.

Quiz Preparation Process serves to retrieve quiz data and answers and shuffle them to generate a random quiz sequence. The quiz will be displayed to the user and they can solve it. The results in form of a value data will be displayed to user and stored in storage.

Google Service Connection Process involves Google Service entity. This process authenticates and connects user's account with Google Play Games Service. Once connected to Google Play Games Service, user can view and unlock the achievements in the application. In addition, this process also connect apps with Google Maps Service with intention to showing the user's location on the map.

B.2. Flowchart

Flowchart is a media representate of work flow of a process to simplify the visualization of a process.

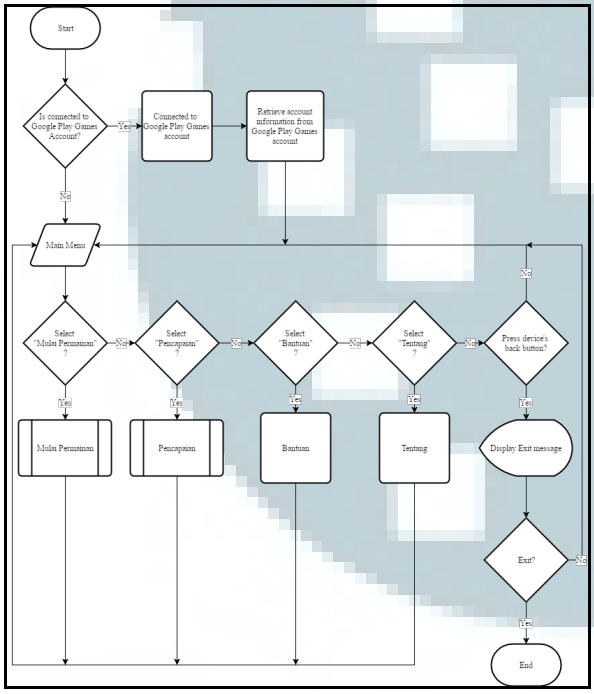

Fig. 2. Flowchart Main Menu

Fig. 2 shows the Main Menu flowchart of Ragunan Zoo Quiz. User that not connected to Google Play Games will have options to link their Google account with Google Play Games. Then the user can select Mulai Permainan (Game Start) menu to start the game, Pencapaian (Achievements) menu to see the achievement list, Leaderboard menu to see the user' scores, Bantuan (Help) menu to see how to use the application, and Tentang (About) menu to see application information.

After selecting Mulai Permainan menu, the app will show a display with a list of areas. User can select the area then will be forwarded to QuizArea page as in Fig. 3 which shows the QuizArea flowchart. In Fig. 3, Quiz Preparation process works to prepare quizzes base on user-selected area. Shuffle process serves to randomize the sequence of the problem that have been prepared by the Quiz Preparation process. Calculate Quiz process works to calculate the results obtained from how many wrong or correct answers and chance that user have after do the quiz. Quiz Complete process serves to display the obtained scores.

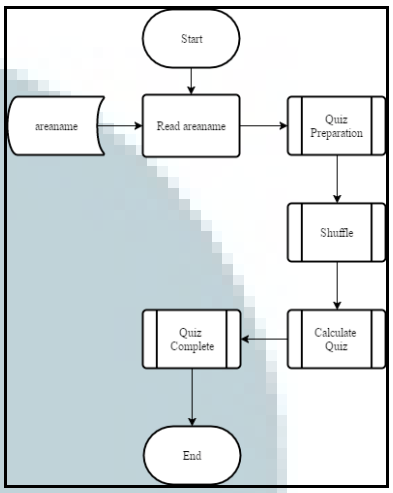

Fig. 3. Flowchart QuizArea

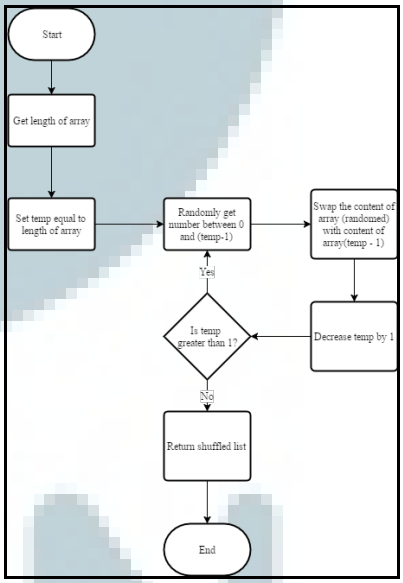

Fig. 4. Flowchart Shuffle

Fig. 4 shows a Shuffle flowchart. After the quiz taken from Quiz Preparation process, Shuffle process will randomize the sequence of the quiz. This process starts by determining the length of the questions' array. Then the length of the questions' stored into the temp variable. After that, a random number is selected between zero and temp minus one, defined as variable x. This selected number will be the index pointer array, defined as variable r. After that, swap between content of array r and content of array x. The temp variable will be reduced by one and checked whether the temp variable is greater than one. If the temp variable is greater than one, the randomize and

swapping process will take place until the temp variable is equal to one. If temp variable equal to one, stop the randomization and swapping and return the random results. The randomize result will be used in Calculate Quiz process. Calculate Quiz process will be calculate the result obtained from randomized quiz sequence and calculate the chance user have. The Quiz Complete process serves to display the calculate score from Calculate Quiz process and unlock the achievement based on score, chance, and area.

IV. IMPLEMENTATION, TESTING, EVALUATION

A. Implementation

Fig. 5. Tampilan Aplikasi Ragunan Zoo Quiz

The application and system design that have been done will be implemented into the Ragunan Zoo Quiz. Fig, 5 shows the result of Ragunan Zoo Quiz implementation. There are five menus: Mulai Permainan (Game Start) menu to start the quiz, Pencapaian (Achievements) menu to see the list of achievements, Leaderboards menu to see the score per area, Bantuan (Help) menu to see the application usage tutorial, and Tentang (About) menu to see application information.

B. Testing and Evaluation

After the implementation of Ragunan Zoo Quiz finish, the next step is to test and evaluate the system. Testing were conducted by test the application to the users. From the population of Kebun Binatang Ragunan visitors, sample of participants were taken using accidental sampling. Accidental sampling is a method of determining sample by chance, i.e. anyone who happens to meet with the researcher and considered suitable as a source of data. Total samples taken as many as 37 repondents. The respondents are filling out the questionnaire after doing the application testing. The questionnaire is a set of questions related to Hedonic-Motivation System Adoption Model (HMSAM), usability measurement, and the influence of achievement use on the motivation of participants using Likert scale. The calculation of Likert scale scores with five scales or categories is shown in Table II with 'X' as the value obtained.

TABLE II. LIKERT SCALE CATEGORY

Category	Code	Weight	Category Interpretation
Strongly Agree	SA	5	$X \geq 80\%$
Agree	A	4	$60\% \leq X < 80\%$
Neutral	N	3	$40\% \leq X < 60\%$
Disagree	D	2	$20\% \leq X < 40\%$
Strongly Disagree	SD	1	$X < 80\%$

From Table II, a Likert scale formula as follows.

$$X = \frac{(SA * nSA) + (A * nA) + (N * nN) + (D * nD) + (SD * nSD)}{amount\ of\ crieria * amount\ of\ sample} \quad (1)$$

Descriptions of (1) are:

- SA is the weight of Strongly Agree equal to 5.
- nSA is the number of response Strongly Agree category.
- A is the weight of Agree equal to 4.
- nA is the number of response Agree category.
- N is the weight of Neutral equal to 3.
- nN is the number of response Neutral category.
- D is the weight of Disagree equal to 2.
- nD is the number of response Disagree category.
- SD is the weight of Strongly Disagree equal to 1.
- nSD is the number of response Strongly Disagree category.

TABLE III. SUMMARY OF QUESTIONNAIRE

#	Strongly Disagree	Dis-agreee	Neu-tral	Agree	Strongly Agree	Aspect
1	0	0	1	23	13	Perceived Ease of Use
2	0	0	13	23	1	Perceived Usefulness
3	0	1	7	20	9	Curiosity
4	0	0	4	24	9	Control
5	0	0	10	22	5	Joy
6	0	0	6	25	6	Immersion
7	0	9	16	10	2	Behavioral Intentionto Use
8	0	0	2	28	7	Learnability
9	0	0	4	24	9	Efficiency
10	0	1	10	20	6	Satisfaction
11	0	0	5	26	6	Motivation

Based on Table III, Likert scale is calculated to represent the aspects of HMSAM.

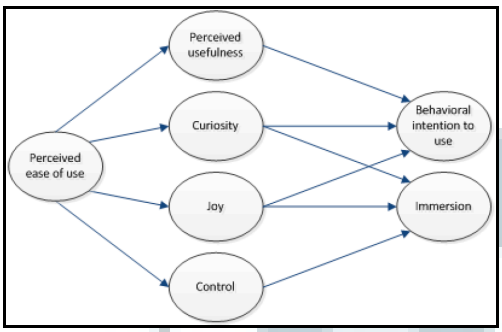

Fig. 6. Hedonic-Motivation System Adoption Model

Based on Fig. 6, there are five HMSAM measurement factors that affect the *Behavioral Intention to Use* aspect and *Immersion* aspect. According to Fig. 6 obtained formulas such as:

$$BIU = \frac{PU + CU + J}{n\ of\ aspect} \quad (2)$$

$$I = \frac{CU + J + Co}{n\ of\ aspect} \quad (3)$$

Descriptions of (2) and (3) are:

- BIU is Behavioral Intention to Use.
- I is Immersion.
- PU is Perceived Usefulness.
- Cu is Curosity.
- J is Joy.
- Co is Control.

HMSAM calculation result are presented in Table IV.

TABLE IV. LIKERT SCALE RESULT OF HMSAM

HMSAM Aspect	Likert Scale Result	Percentage and Likert Scale Interpretation
Perceived Ease of Use	0.864864865	86.49% (Strongly Agree)
Perceived Usefulness	0.8	80% (Strongly Agree)
Curiosity	0.832432432	83.24% (Strongly Agree)
Control	0.845945946	84.59% (Strongly Agree)
Joy	0.818918919	81.89% (Strongly Agree)
Immersion	0.824324324	82.43% (Strongly Agree)
Behavioral Intention to Use	0.769594595	76.96% (Agree)

The *Behavioral Intention to Use* aspect result around 76.96% dan *Immersion* aspect result around 82.43%.

Based on Table III, a Likert scale calculation performed and representd *usability* and influence of achievement in participants' motivation aspect. The calculation result are presented in Table V.

TABLE V. LIKERT SCALE RESULT OF USABILITY AND MOTIVATION

Usability and Motivation Aspect	Likert Scale Result	Percentage and Likert Scale Interpretation
Learnability	0.827027027	82.7% (Strongly Agree)
Efficiency	0.827027027	82.7% (Strongly Agree)
Satisfaction	0.767567568	76.76% (Agree)
Achievement as Motivation	0.805405405	80.54% (Strongly Agree)

Learnability aspect is around 82.7%, *Efficiency* aspect is around 82.7 %, and *Satisfaction* aspect is around 76.76%. The influence of achiement in participants' motivation is around 80.54%.

Beside the application testing by participants, Sattolo Shuffle algorithm also tested to prove randomness using Sattolo shuffle produce a unique randomization. This testing was conducted on 81 quiz questions with 50 randomization tests. From these 81 quiz questions, the first ten questions were taken to show the uniqueness of randomized sequence.

TABLE VI. SATTOLO SHUFFLE ALGORITHM TEST

Quiz Sequence	Occurence
6 10 7 2 8 5 9 3 1 4	1
1 5 8 10 7 2 4 6 9 3	1
4 1 6 5 7 10 3 9 8 2	1
3 7 6 9 4 5 10 2 8 1	1
2 6 3 7 5 4 8 1 10 9	1
6 5 10 2 3 4 7 9 1 8	1
2 5 1 3 10 4 7 6 8 9	1
9 3 8 6 5 2 10 7 4 1	1
3 8 2 1 6 9 4 7 5 10	1
9 7 4 3 6 2 5 8 10 1	1
5 8 4 7 1 9 3 2 6 10	1
6 10 4 2 5 3 9 7 1 8	1
4 10 6 2 5 7 9 3 1 8	1
9 10 4 1 8 6 5 3 7 2	1
2 7 10 1 5 3 4 9 8 6	1
7 5 9 3 8 2 10 6 4 1	1

Quiz Sequence	Occurence
3 8 2 9 7 4 10 5 6 1	1
10 3 8 7 6 1 4 2 9 5	1
2 10 4 7 3 5 9 6 1 8	1
2 1 10 4 9 3 8 7 6 5	1
8 9 3 7 2 10 3 5 4 1	1
6 2 3 8 4 7 1 9 10 5	1
8 2 7 5 1 9 3 4 10 6	1
4 3 4 1 10 9 7 2 8 5	1
6 10 4 7 8 5 2 7 1 3	1
7 5 6 1 9 8 10 3 4 2	1
8 4 10 9 6 7 1 5 2 3	1
9 4 1 2 6 10 3 8 5 7	1
10 8 9 3 1 6 7 4 5 2	1
4 10 6 5 7 8 1 9 3 2	1
3 6 5 8 4 2 7 10 1 9	1
1 8 9 5 4 10 2 3 6 7	1
2 8 10 6 7 3 6 5 1 4	1
4 3 10 6 7 5 8 1 9 2	1
5 3 6 2 9 8 10 1 4 7	1
6 10 8 3 5 9 4 2 1 7	1
10 6 7 8 3 1 2 9 4 5	1
10 2 1 9 3 8 4 7 5 6	1
5 4 3 6 1 9 7 2 10 8	1
5 6 9 7 8 1 4 10 2 3	1
9 5 8 1 7 10 4 2 6 3	1
4 7 2 3 10 5 9 6 1 8	1
4 7 3 1 6 8 9 5 10 2	1
3 6 8 2 1 7 10 9 5 4	1
9 6 5 2 7 4 1 8 10 3	1
7 2 5 3 4 10 8 6 1 9	1
10 6 4 3 2 5 8 1 7 9	1
6 5 3 7 1 4 2 9 10 8	1
7 2 4 10 6 9 8 6 5 1	1
2 6 1 5 3 9 10 7 4 8	1

Table VI shows number of occurences of the randomized question sequence is one. It means in 50 tests yielded 50 different sequence variations. The conclusion of this test is the usage of Sattolo Shuffle algorithm in Ragunan Zoo Quiz can generate unique sequence of question.

V. CONCLUSION

1. Animal recognition quiz application using gamification method and Sattolo Shuffle algorithm on Android platform has been successfully designed and built, named Ragunan Zoo Quiz. This application already has seven gamification elements such as *points, levels, leaderboards, achievement and badges, challenges and quests, onboarding,* dan *social engagement loops.*
2. Ragunan Zoo Quiz generate *Immersion* rate around 82.43% which means users strongly agree that using Ragunan Zoo Quiz can keep them focused using the application and *Behavioral Intention to Use* rate around 76.96% which means users agree to use Ragunan Zoo Quiz in the future.
3. Ragunan Zoo Quiz also produces *Learnability* aspect around 82.7% which means users strongly agree that Ragunan Zoo Quiz is easy to use and fast to learn, resulting *Efficiency* around 82.7% indicating users strongly agree no need excess effort in using application, and *Satisfaction* around 76.76% which shows that users agree to the satisfaction gained after using Ragunan Zoo Quiz.
4. The influence of achievement usage to motivate users produced result around 80.54% indicating users strongly agree that achievement usage affect the users motivation to use Ragunan Zoo Quiz.
5. Sattolo Shuffle algorithm also successfully applied to randomized question and generate an unique sequence. This statement proven by 50 randomization tests and produced 50 unique sequence variations that different from each other.

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