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Utilization of Game Techniques as a Test Tool to Measure Persistence of Applicants

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***Abstract*—This research was conducted at PT. XYZ, which utilizes the game elements in the process of psychological test. This game-based test is intended to measure the persistence of applicants (management-trainee position) and to replace Pauli Test, which is administered through a paper and pencil test method. Results of the game-based persistence test are proven to have a positive correlation with the measurement of persistence in the measurement of persistence on the Pauli Test (p-value <.05, koef. Correlation (+)). This project was developed using iOS platform from Apple, which automates the process of psychological test by applying Computer Based Test (CBT) which uses iPad media.**

***Index Terms*—Computer Based Test; Game; Persistence; Psychological Test**

I. INTRODUCTION

The development of technology that is accompanied by the increase of business competition has pushed almost every organization to innovate and provide added value in supporting the daily business processes, including the recruitment process of human resources (HR). By viewing the needs of growing business, PT. XYZ is constantly trying to get superior human resources and qualified (high quality talent). Superior human resources and qualified can be seen from the beginning of the recruitment process through a series of tests given in the selection process such as: ability test, personality test, and persistence test.

The main issue often faced by HR recruitment section is the process of recruiting candidates, which is long and complicated. The selection process in the form of Pauli Test is to measure the persistence of candidates. It is still paper-based because Pauli Test or also known as paper test is using a similar answer sheet to paper size. Psychological test results on the answer sheets are then checked manually which of course require quite long and complicated administrative work. Besides, the accuracy of test results is potentially inaccurate due to human error and fatigue in conducting examination manually.

To innovate in the process of persistence test, then it is required a new breakthrough in providing new test instrument using computer technology. [1] Shows the relationship between Video Game and the measurement of persistence performance. Persistence can be measured by recording the time spent for the unsolved game. [2] States that the use of media such as paper or the use of technology do not give any effect to the validity of test results. Therefore, the implementation of game-based test by including elements contained in the game is expected to be used as a substitute for Pauli Test, so that it can shorten the selection process of prospective employees at PT. XYZ. Besides, this instrument of game-based test can measure the persistence of applicants and have a positive correlation with the measurement of persistence in the Pauli Test (p-value <.05, koef. Correlation (+)).

The game genre used as a test in this research is the puzzle game. Puzzle games are games that require the player to find a solution to a problem while still adhering to a set of game rules. Usually, puzzle games rely heavily on logic which involves a timing element and requires quick thinking. Therefore, this puzzle game genre is used to replace the Pauli test, where the Pauli test is intended to determine a candidate's level of persistence, accuracy and speed when facing a problem.

II. LITERATURE REVIEW

A research of [3] states that the game can be used as a test instrument to determine a person's level of persistence. In the study, the measurement of persistence was using Anagrams and Riddles. Games consist of two levels of difficulty namely easy and hard. The time needed to complete each game is 120 seconds. The failure in every game is due to unsuccessfully complete within 120 seconds at a particular level. The game at that level is still possible to be repeated in 120 seconds. The persistence assessment is only done on a game that fails to be solved (unsolved) generally occurring in the game with a level of difficulty (hard). The assessment is based on the length of time in which someone plays the game before doing repetitions or finally timed out.

The time spent by participants to work on unsolved game increasingly decreases in the overall game. It occurs due to fatigue or participants choose 'skip' on the game level that is deemed difficult to resolve. Persistence is measured by recording the time spent on unsolved anagrams and riddles. The time spent on unresolved issues correlates with the standard of persistence.

The test used [1] as a measure of performance-based persistence is through Anagram Riddle Task (ART), which measures how long participants spend the time in completing difficult tasks. ART is provided online via internet and the anagram is presented with a level of difficulty (hard) and (easy) and accompanied by a series of puzzles test that must be answered one by one.

The tasks performed by the participants are among others to type their response for anagram or riddle into a text-box and then press the "guest" button. If the answer is wrong, the screen displays "incorrect" and the individual can try again until the time limit of 120 seconds is reached.

Any time, the individual can also choose to press the "skip" button if he wants to leave the task level and go to the next level. If the individual can guess correctly, then it will be is presented with a new task level. A trial is classified as "solved" if someone accurately solves a given task. The trial is classified as "unsolved" if someone skips to the next level or past the deadline after 120 seconds. The reason why allows participants to "skip" when he gets a difficult task is to see the extent to which a person survives on difficult issues when he is given the option for not survive.

The research method of [4] was conducted to 102 students enrolled in the program of educational psychology at Florida State University to participate in this study. The majority (81%) of the sample were female (n = 83). Students followed all assessments and Anagram Riddle Task (ART) via online according to the time of the students themselves. The instruction given to participants is that they must solve as many as possible anagrams and riddles provided. Participants were also told that some of the anagrams and riddles will have a hard difficulty level and if they cannot solve the anagram, they have the option to "skip" to the next level. Participants are not timed, but there is a limit of 2 minutes on each level. If the limit of 2 minutes is passed, then the participants will be presented with the next level.

In this study, the students were asked to complete ART consisting of 28 anagrams and 20 riddles. Anagram is a series of letters that can be rearranged to form a word. For example, the switched letters of YBO can be rearranged to be BOY, so that they have other meanings. The student task is to rearrange the letters into a word. Some words have a level of difficulty that is difficult and should be tried to do our best in order to form a word from the anagram. All of the anagrams are made by ourselves so that they will not find the answers via online. Among the anagrams, there are 12 anagrams with hard levels and 16 easy levels, where the level of difficulty is determined by the pilot work. Anagram of hard level is derived from the words that are rarely obtained from the dictionary. Since the anagram is only in the form of character (string), then the answer cannot be found on the web via online.

Students were also asked to answer 20 riddles. All riddles are also made by ourselves, so the answer cannot found via online. Among the riddles, there are 12 hard levels and 8 easy levels. All of the riddles are also made by ourselves to ensure that participants will not get the answer on the web.

If students have any difficulty to solve the anagrams or riddles, they are allowed to pass the level by pressing the "skip" button. The combination between anagrams and puzzles with hard and easy difficulty levels is intended to ensure that participants do not get too frustrated which can disrupt the persistence aspect. In addition, for hard level, it does not mean that it cannot be solved at all, but it is truly able to be solved. The selection on the sequence of hard and easy level is done by ensuring not too many hard levels consecutively and Anagram Riddle Task is presented in four blocks.

For the results of report with a high variability in the testing process of ART, then it is made a log that calculates all the time data during the testing. In addition, it is also conducted a recording on the number of trials that are successfully solved for the anagrams and riddles. The total of anagrams successfully completed is more significant than the riddles that are successfully completed. Moreover, the time of unsolved anagrams is not significantly different from the time of unsolved riddles, but the completion time of solved anagrams is shorter than the completion time of riddles solved. During sampling, the hard difficulty level was successfully completed by 24%, while the easy level was solved amounting to 95%.

The result obtained from this study is unsolved ART that significantly correlates with the standard of persistence. Therefore, the length of time a person spends time on a difficult problem to be solved, and then the higher level of persistence is reported.

The results of this study have shown that playing the game can make a person more "resilient". [5] Writes in the Harvard Business Review about the people who regularly play games that can be better problem solvers, more collaborative, and unlikely to give up easily. In other words, the game can make people more resilient.

Playing digital games has been shown to be positively related to a variety of cognitive skills [3] [6] attention [7], personality traits [4] [8] [9], persistence [1], academic performance [3] [10], and civic engagement [11].

According to [12], games provide a potentially valuable tool because they provide opportunities for

cognitive and metacognitive engagement and are typically highly motivating. [13] show strategic video games promote self-reported problem-solving skills. And [14] provides empirical evidence of a highly specific use of games in education¬ the assessment of the learner. Linear regressions were used to examine the predictive and convergent validity of a math game as assessment of mathematical understanding.

[15] builds an evidence model for the assessment of persistence from Poptropica, a popular commercial game for children. Task persistence is an important skill related to successful school and work outcomes, particularly given new, complex tasks requiring sustained application of effort. Evidence extracted from log files of the game was used to identify players with a particular goal and then create a measure of persistence toward that goal. Task persistence is defined as continuing with a task despite obstacles or difficulty.

According to [16], persistence can play an important role in learning in a video game due to the design principle of challenge in well-designed games. [17] showed that trying to complete difficult tasks can improve persistence. Participants were randomly assigned to solve impossible, hard, or easy anagrams and then take the perceptual comparison task where they were asked to detect as many differences as possible between two pictures.

Research from [18] states that challenge in video games has some association with positive reactions to failure. [19] states that digital games can be used as vehicles for measuring and enhancing persistence. Study from [20] states that game failure facilitates persistence when players can identify a purpose. [21] states that gaming and interactivity have been suggested as essential features in increasing persistence in online learning. Experiment from [22] shows that participants who experience setbacks and defeat multiple times still show interest towards playing a game that has challenging gameplay.

III. RESEARCH METHODOLOGY

In this study, the writer analyzed the application of Game Based Test as a replacement for Pauli Test because based on the findings, the implementation of Pauli Test takes a fairly long time. The test process lasts for 60 minutes and the examination of Pauli Test results takes 5 minutes per answer sheet. In fact, one of the essential elements in the recruitment process of HR is the speed of announcement on the test results in order that candidates can immediately know whether they pass the test or not.

As shown in figure 1, the framework for this research begins with identifying problems that occur in the process of implementing the Pauli test, collecting data which is summarized for analysis using qualitative data analysis through several interview questions, analysis of test results, and recommendations.

In the development of Game Based Test, is required stages starting from an idea into a game that can be played. In this study, there are four stages should be passed for designing a game, namely: (1) Game Concept. The earliest stage in the creation of a game is to determine the purpose and theme of the game that will be made (adventure, puzzle, simulation, or others). This stage begins with conducting a research and preparation of basic concepts. Before starting to make games, then it is determined what kind of game concepts will be created, the number of players, how to play and what will make people happy to play this game. The main point at this stage is also formulated the patterns, rules or mechanisms of how the interaction process of players with the game that will be created. (2) Pre-production. This stage begins with the preparation of various technical matters relating to the game that will be created, for example, what media (platform) will be used, the programming language, determining the level of design or classification of difficulty level as well as various appropriate assets at each level in order that the game can bring an optimal gaming experience. This stage includes determining all of characters as well as the assets needed such as characters, sound/music, the kind of graphics will be used (cartoons, semi-real or real), to increase the interest of players towards the game created. Besides characters, at this stage is also created a game scenario using the characters determined before. Scenario in a game is very important in order that people playing games (player) will be directed in accordance with the scenario that has been made and to ensure that players do not get bored. If the game is too difficult, the player is likely to be lazy on the contrary if it is too easy, the player will become bored and less challenged, so that it requires a dynamic scenario and can adjust to the player's ability and the emergence can be random. At this stage, a prototype/dummy is presented to test the gameplay as well as various concepts that have been arranged, both in each level and overall, as well as perform various improvements required. This stage also serves to provide a complete overview so that it can facilitate the process of further development. (3) Production. Production stage is the stage where the game is developed into a product that is ready to use. In this stage, a lot of work is done, among others, the creation of all game assets, to implement all of assets into the game and including to conduct trials in the game. The main points in this stage are the entire concepts (characters and assets) that previously had been arranged, are started to be fully developed, the game engines are started to be developed and all the elements are started to be integrated. (4) Post-production. Post-production stage is the last stage in the process of game development. At this stage, it should be ensured that all major components of the game have been able to provide user experience as expected, as well as to detect any technical problems that have not been detected at the previous stages. If all are finished, the production of this game is ready to be implemented to users.

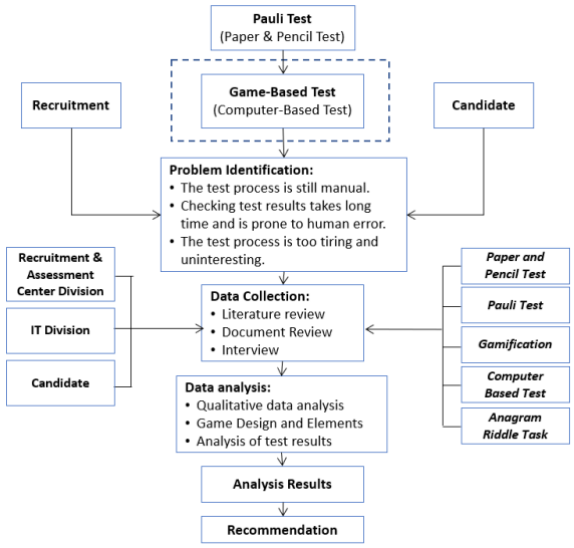

Fig. 1. Conceptual Framework

To conduct an evaluation on the Game Based Test, it will be used the type of puzzle game where the number of questions consist of 30 levels with 3 levels of difficulty, they are: 12 questions of easy level, 8 questions of medium level and 10 questions of hard level. The level cycle is not presented increasingly difficult (incremental), but it is combined between easy-medium-hard to rebuild the spirit of the participants in doing the puzzle test, because the goal of this game is to assess persistence as seen from the efforts to complete the task successfully. Although there are many obstacles, but they keep trying to complete the task. However, they are still allowed to skip levels if they do not want to continue their efforts.

Level with hard difficulty level is not intentionally made into a level that cannot be solved (impossible) but it is made into extremely hard level to ensure that all levels can be solved by the participants. This game application has already been developed with tools XCode 5, programming language Objective C, storage Core Data and library/engine Cocos2D-iPhone 2.1. The development of this application has been done using the native language of iOS namely Objective-C. While for the storage of test result data is on Core Data because Core Data is a native and standard feature from iOS for data storage. The selection of Cocos2D-iphone as a game engine used in the development of this game is because Cocos2D-iPhone using pure Objective-C so that it will fully compatible to be integrated with the existing iOS application.

Evaluation method used on the Game Based Test method is measured based on the performance of participants in the test items with hard difficulty level. The measurement is performed on the first hard question that is done (either successfully completed or not successfully completed). The scoring system specified is the calculation of duration needed by participants to solve the first hard question (in seconds). Furthermore, to know that the persistence test (Game Based Test), which is measured by the duration in answering the first hard question is valid in measuring the persistence, then it will be proven through correlation test with the measurement of Pauli Test. The results of correlation test between Game Based Test and Pauli Test will use a software named Statistical Packages for Social Science (SPSS), which has been used by the Recruitment & Assessment Center Division as a program for statistical analysis.

IV. Results and Discussion

To provide innovation in the recruitment process in PT. XYZ is required a new breakthrough in providing new test instrument by utilizing computer technology. The innovation of software developed for the needs of recruitment at PT. XYZ in conducting an analysis on the persistence level of test participants is in the form of Game Based Test. The development of this game is using the concept of gamification, namely the utilization of game elements in a non-game context.

The activities performed by the user will be recorded during the game and then sent to the server at the end of each session to be analyzed. The selection of game in the form of puzzle with a target of young adult players (all gender), played by a single player in the iOS platform. In this game, there are 30 levels divided into 3 levels of difficulty, they are easy, medium and hard. This game is made to be implemented on the device Apple iPad 2 screen resolution of 1024x768 and 2048x1536 (retina display) with the operating system iOS version 8.

As shown in figure 2, workflow of the game in outline is started from the home page (cover). Then from the home page, the user will go to the story line page, in which there will be described briefly about the purpose of the game played. After that, the user will go to tutorial page, which will be explained interactively about the basic of mechanism of this game. This tutorial page will visually be similar to the game level page, but the user will be guided step by step.

On the game level page, besides playing a puzzle game if the user cannot solve the existing puzzle, there will be popup skip level, where the user is given an option to skip the level and go to the next level or the user may choose to stay at that level. Every a level is completed, there will be an animation as a visualization that the level is successfully completed. After a certain time (default: 30 minutes), the time will be over and is marked with popup that the time is over and the user will go to the ending page.

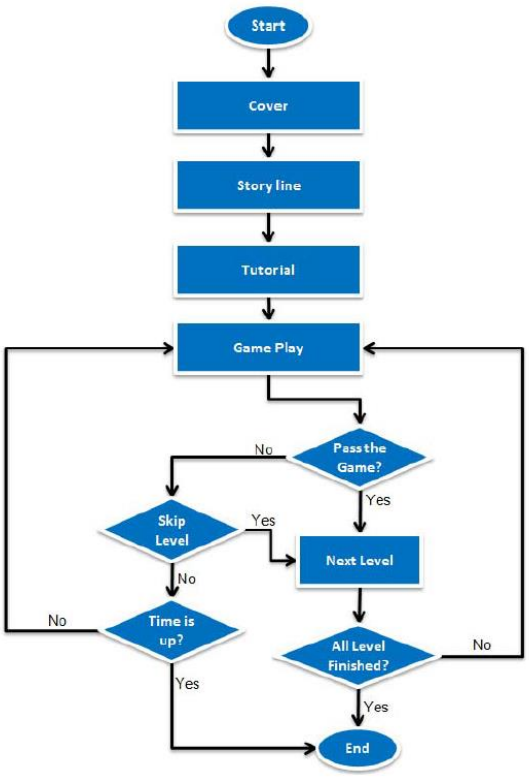

Fig. 2. Game Flow

User must perform authentication in advance before play the game. As shown in figure 3, authentication of game application is done using Face Recognition Authentication system so that this application will get user data based on the results of authentication. During played by the user, the game will store the data of analytical results in the internal database for each session, and then at the end of session, the data will be sent to the server by sending JSON data to API web service that has been provided by the server.

The database in Figure 4 has been called since the authentication process used face recognition to be able to enter the cover page as in Figure 2.

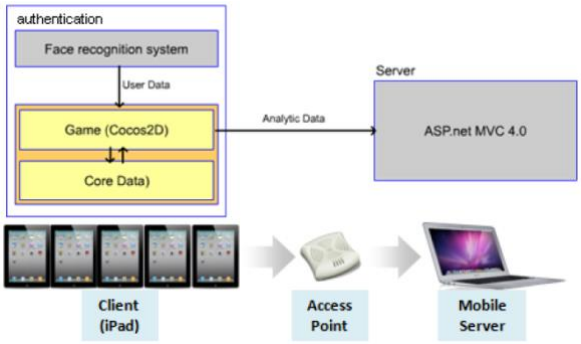

Fig. 3. Architecture Chart of the Game

As shown in figure 4, the data stored in the form of "raw", in the sense of truly activity data and its timestamp. So that, to obtain the data such as number of taps per level, whether the idle and others still require further data processing by an analyst team. Activities conducted will be carried out with key-value format so that it can be flexible and if there is another activity that want to be recorded, do not need to change the database scheme.

Fig. 4. Database Chart

A. Presentation Design

As shown in figure 5, the display page of this game broadly includes game elements as follows: (1) Avatar: a character that is made to make the players feel involved in the missions of this game. This character is named Professor Astro. (2) Instructions: a page that explains the purpose of the game and how to play it. (3) Level: a facility to show the progress of a player in this game. Level is indicated in the form of a label containing numbers where the player is located. The label itself is located in the middle upper part of the screen in every page of the game. (4) Progress: a facility to show the development of the game of a player in a certain level. The progress indicates the percentage of area that is already filled. This pointer is located in the same label with Level. (5) Help button: a facility for players to return to the instruction page. This button is located on the top left of the screen in every page of the game. (6) Left Arrow key: a facility for players to shift the bar that contains the pieces of puzzle to the left side. The key itself is located on the bottom left of the screen in every page of the game. (7) Right Arrow key: a facility for players to shift the bar that contains the pieces of puzzle to the right side. The key itself is located on the bottom right of the screen in every page of the game. (8) Serrated left arrow button: a facility for players to stay at the level that is being played when the time of 3 minutes is exceeded. (9) Skip button: a facility for players to pass through the level that is being played and advance to the next level. (10) Puzzle: a facility for players to fill the puzzle area in the game. These pieces of puzzle are likened as a piece of machinery that will be reassembled into a large machine, which is the goal of this game. (11) Puzzle area: an empty area that must be filled by players with the pieces of puzzle to

complete a level. The size and shape of this area is different at every level.

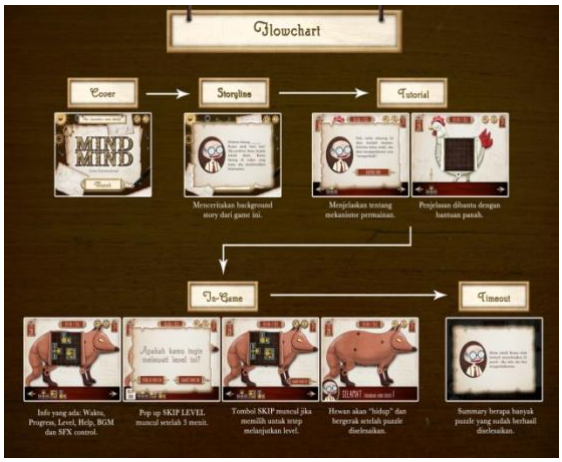

Fig. 5. UI Chart of Game Puzzle Design

B. *Testing of Game Based Test*

Testing of Game Based Test is performed to analyze the gaming system that is designed to be implemented by Recruitment and Assessment Center Division at PT. XYZ. [23] suggested that a sample size greater than 30 and less than 500 is suitable for most behavioral studies. From the criteria mentioned, then the number of participants used for the testing of Games Based Test as many as 37 candidates. The measurement of Game Based Test is based on the performance of participants on the test items with hard difficulty level. The measurement is performed on the first hard question that is done (either successfully completed or not successfully completed). The scoring system specified is the calculation of duration needed by participants to solve the first hard question (in seconds).

To get the value, then the scores from the test results which is essentially still in the form of a time duration (in seconds), need to be processed in advance so that it should be converted into standard scores, with the formula as seen in figures 6 and 7. One of the ways to convert raw score into standard value is by using STEN norm (standard ten). [24] states standardization is the requirement that a test's results are comparable to some baseline or norm and are therefore interpretable. According to Canfield, A. A. (1951), the STEN norm ranges from 1 to 10, has a mean of 5,5 and a standard deviation of 2. The conversion technique of STEN norm is changing the raw scores into standard scores in scale of ten (in the range of 1 to 10).

Fig. 6. Formula Raw Score, Z-Score, Standard Score

Based on the scoring standards (norms) from the calculation of test results to 37 candidates, then its is known that the mean of duration in answering the first hard question is 381 seconds. By calculating the mean and standard deviation, it can be obtained the following norm table 1:

TABLE I. CONVERSION OF RAW SCORES INTO STANDARD SCORES

RS *(Raw Score)*	**SS *(Standard Score)***
-	1
-	2
0-183	3
184-380	4
381-577	**5**
578-775	6
776-972	7
973-1169	8
1170-1367	9
>1368	10

Thus, it can be concluded that the minimum duration limit in answering the first hard question on Game Based Test is 381 seconds. Participants who pass the duration limit can be declared passing the persistence test.

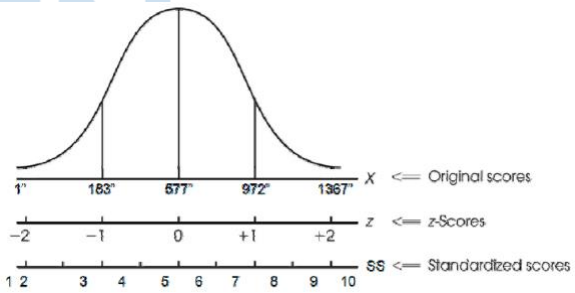

Fig. 7. Comparison of Raw Score, Z-Score, Standard Score

C. *Validity Results of Game Based Test*

The results of correlation test between the persistence test using Game Based Test and Pauli Test showed a significant positive correlation (N=37, p-value < .05) as shown in table 2. Thus, it can be concluded that the persistence test using Game Based Test measured by the duration in answering the first hard question is valid to measure the persistence, as evidenced through positive and significant correlation test with the measurement of Pauli Test.

TABLE II. THE CORRELATION CALCULATIONS BASED ON A SOFTWARE OF STATISTICAL PACKAGES OF SOCIAL SCIENCE

Correlations		
	Persistence (Pauli Test)	**Duration** (Game Test)
Persistence (Pauli Test) Pearson Correlation	1	.277*
Sig. (1-tailed)		.048
N	37	37
Duration (Game Test) Pearson Correlation	.277*	1
Sig. (1-tailed)	.048	
N	37	37
*Correlation is significant at the 0.05 level (1-tailed)		

V. CONCLUSION

Based on the implementation results of Game Based Test as one of the methods to measure persistence of candidates, it can be concluded that: (1) the utilization of Game Based Test shortens the time used to carry out the recruitment process because it automates the conventional process of psychological test. The duration given for the Pauli test and Game Based Test is both 30 minutes but the test result scores can be generated in 30 seconds after the test process is complete, rather than manually checking the Pauli test sheet which takes 5 minutes per sheet. (2) The results of persistence test are obtained faster than using examination (scoring) of Pauli Test, because the scoring process of Game Based Test and the preparation of reports are already automated. The use of Game Based Tests and test reports that can be produced more quickly within 30 seconds certainly provides benefits for companies such as speeding up the candidate recruitment process (reducing recruitment lead time), reducing human error in correcting Pauli sheets (more accurate with automatic assessment calculations), reducing use of Pauli sheets (paperless), using impressive test tools to attract candidates (create company branding). (3) From the test results of Games Based Test to candidates, most of candidates understand to use this application after reading the tutorial (user guide) that is already available in the application. It can be seen from the timestamp when the candidate is on the tutorial page with an average duration of 163 seconds. (4) By applying the game elements in the recruitment activities, a test process that formerly seems boring, but now it becomes more attractive although it still need to concentrate when taking the test. This response was obtained from 6 recruiters' feedback regarding game experiences when testing the game based test (5) Game that is measured through the duration in answering the first hard question is valid to measure persistence, as evidenced through positive and significant correlation with the measurement of Pauli Test.

The contribution from this research can be used as a reference for companies to speed up the process of recruiting candidates through the implementation of Game Based Test with automated scoring and reporting.

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