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Case study

A Practical Usability Study Framework Using the SUS and the Affinity Diagram: A Case Study on the Online Roadshow Website

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ABSTRACT

Online Roadshow has many benefits in promoting a concept or a product to the public. It is a new model with the same purpose as a physical roadshow but with higher scalability and flexibility in terms of time, location, target audience, resource utilization, and data collection capability. However, the prototype implementation of the new model has not been evaluated for its usability. As ISO standards defined, usability has three key elements: *effectiveness*, *efficiency,* and *satisfaction*. The *effectiveness* and *efficiency* are highly dependent on the different systems, while *satisfaction* is measurable by System Usability Scale (SUS). SUS is a quick and easy technique where the usability of a system can be assessed in a short time. However, the result of SUS is only a grading scale, with no information on the problematic areas. Hence, this paper introduces a practical framework that combines the SUS with the Affinity Diagram. With the intention of maintaining the simplicity and elegance of the SUS, an additional open-ended question is asked to assess the usability problem of the website. The proposed practical SUS plus one open-ended-question usability-testing framework was applied to the Online Roadshow website. Since the average SUS score for the Online Roadshow website from the test was relatively low, the Affinity Diagram was used to analyze the open-ended comments from the user. As a result, the practical usability framework identified the usability problems on the Online Roadshow website to assist the developers in improving the usability.

Keywords: Affinity diagram, online roadshow, practical framework, SUS, usability

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INTRODUCTION

Online Roadshow is an event held by an organization on the Internet to promote a certain product or a concept (Leow et al., 2021). It is a new conceptual model that is adapted from a physical roadshow. It has the same purpose as a physical roadshow, but it is held virtually as an Online Roadshow website. Nevertheless, the Online Roadshow brings many benefits over its physical counterpart. It has higher scalability and flexibility of location, time, target audience, resources, and data collection. The location and time are no longer restricting factors since the Online Roadshow is being held online, thus available at all times. It also has the advantage of targeting a larger audience without the limitation of geographic segmentation. Also, it has the advantage of analyzing data in real-time after large-scale data collection. Besides, the cost of holding the Online Roadshow is less than a physical roadshow from the long-term perspective. Once the means to hold the Online Roadshow has been developed, it can be reused repeatedly to promote other products or concepts. Since the Online Roadshow demonstrates many benefits over a physical roadshow, usability will be the utmost concern for the organization. However, the usability of the Online Roadshow is yet to be discovered since the Online Roadshow is a relatively new concept proposed by Leow et al. (2021).

Usability has many definitions that different authors often redefined over the years (Rusu et al., 2015). In 2014, Lewis introduced the concept of summative usability, which is measurement-based usability defined by the ISO standards. It emphasizes the three key factors of a system-*effectiveness* (the accuracy that the users can achieve a specified goal), *efficiency* (the resource expended in relation to effectiveness), and *satisfaction* (the freedom of discomfort or positive attitude towards the user of the product). Although ISO standard 9241 defined the key factors of usability, the measurement for the *effectiveness* and *efficiency* varied according to different systems (Abran et al., 2003). For example, the *effectiveness* of a word processing software can be measured by the total number of letters that have been written, while the accuracy can measure the *effectiveness* of a timer program in providing a countdown to the user. On the other hand, a standardized measurement technique for the *satisfaction* aspect of usability was introduced by Brooke in 1996. It is also known as the System Usability Scale (SUS), a quick and easy technique to assess the usability of a system. SUS is a questionnaire containing ten Likert scale questions, scaling from *strongly disagree* to *strongly agree*. The mean of the result scores from all users shows the user satisfaction towards the system according to a grading scale. SUS is considered quick and easy to evaluate the usability of a system because it comprises a comparatively small number of questions that can be completed in a relatively short time. A user is more likely to complete a 10-question-questionnaire, especially when they are frustrated with the ambiguous instruction of a system (Brooke, 1996). Consequently, any organization that wants to apply SUS to evaluate the usability of its system can easily do

so and does not need to customize a long list of questions, such as CSUQ and QUIS (Finstad, 2006). However, regardless of the high or low evaluation score of the system, SUS does not provide systematic guidance on how to improve a system. The weakness of the system is ambiguous to the system developer since the reasons for such a low evaluation score are not clearly defined.

This paper proposes a practical framework to evaluate usability to provide a simple means to extend the functionality of the SUS while maintaining its elegance to solve the problem. The proposed framework is pilot tested on the Online Roadshow website, which aims to educate the public on the awareness of the COVID-19 pandemic. The practical framework, as shown in Figure 1, combines the SUS and the Affinity Diagram. SUS is a quick, easy, and effective technique to evaluate the usability of any system compared to other extended usability measurement tools such as UMUX-Lite, an implementation of the Technology Acceptance Model (TAM) (Lewis, 2018). On the other hand, an Affinity Diagram is commonly used to unify an enormous number of additional comments. This tool helps to categorize the comments received from the users on various problems and feelings they experienced using the system in a more structured and systematic manner. Therefore, the proposed practical framework extends the strength of the SUS in usability measurement by asking one open-ended question after the ten questions of the original SUS on the details of the usability of the system. The open-ended question is then analyzed by leveraging on the structure and systematic nature of the Affinity Diagram.

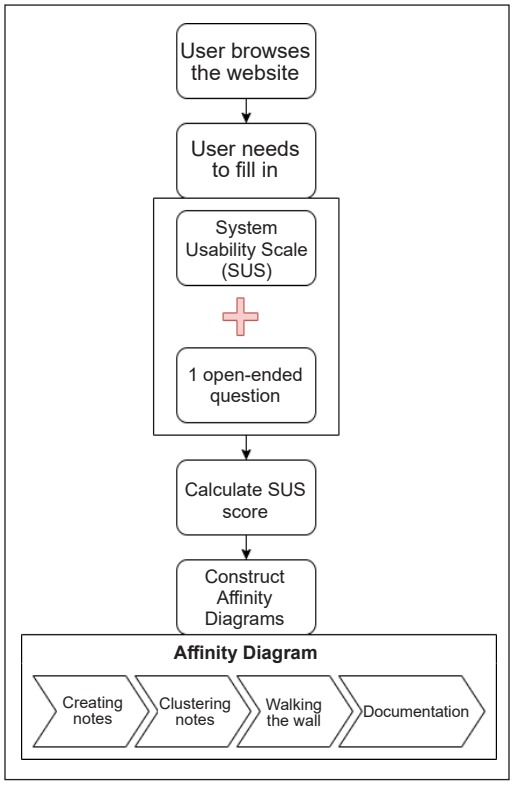


Figure 1. The practical framework that evaluates the usability of the Online Roadshow website

This paper discusses the related works on SUS and Affinity Diagram in the Related Work section. Subsequently, the interfaces of the Online Roadshow website and the method of applying the practical framework to the Online Roadshow website are discussed in the Methodology. The results on scoring the SUS and the relevant Affinity Diagrams are presented in the Result section. Discussion and Recommendation discuss the observation made on the experimental results. Lastly, the conclusion on the work is included in the Conclusion section.

RELATED WORK

System Usability Scale

Satisfaction is measured by System Usability Scale (SUS). SUS is a Likert scale where a user has to rate statements with a 5 or 7-point scale from *strongly disagree* to *strongly agree* (Brooke, 1996). The idea of SUS is that it narrows down all the comments from the users since everyone has a unique perspective regarding the usability of a website. For instance, some might give an example of the small font; some might provide an example of the inconsistency of color. Then, those feedbacks from a group of respondents will be collected and rated by other respondents. The most extreme responses were selected, forming the questions in SUS. SUS helps evaluate the users' satisfaction without establishing a specific standard for a well-designed website (Lewis & Sauro, 2018). Hence, Sauro and Lewis collected a large sample size of SUS scores from different systems to develop the grading scale shown in Table 1. SUS is widely applied in the industry to evaluate the usability of the system built. For example, Kaya et al. (2019) applied SUS to assess the usability of some mobile applications such as Facebook, WhatsApp, YouTube, and Mail. As a result, those popular mobile applications have high average scores of 80.63 in SUS. Also, Islam et al. (2021) applied SUS towards the mental health care mobile application they developed. It scored 79.875 in SUS, an A- based on Table 1. SUS is highly popular and becoming more relatable in the industry due to its practicality, even though it was invented in 1996. However, the evaluation score lacks specific details on the strengths or weaknesses of the system evaluated.

Table 1
SUS score grade scale

Grade	SUS
A+	84.1-100
A	80.8-84.0
A-	78.9-80.7
B+	77.2-78.8
B	74.1-77.1
B-	72.6-74.0
C+	71.1-72.5
C	65.0-71.0
C-	62.7-64.9
D	51.7-62.6
F	0-51.6

Affinity Diagram

An Affinity Diagram is a technique to analyze open-ended comments by categorizing independent responses into groups that share common topics (Hicks et al., 2018). It is a common tool used in the DiGRA community to analyze open-ended responses. Lucero has explained that building the Affinity Diagram comprises four steps: creating notes, clustering notes, walking the wall, and documentation (Lucero, 2015). First, creating notes involves receiving comments from users in a sticky note or digital form. Second, clustering notes involve the process of grouping similar comments together. Third, walking the wall is the process of discussing the relativity of a particular group's comment. If the main topic of a group is not relevant, the Affinity Diagram of the group will be pruned out. Fourth,

documentation is where the Affinity Diagrams produced will be documented digitally and observed the issues raised by the users. Lucero has applied these four steps to generate the Affinity Diagrams based on all kinds of comments received from a group of users after they performed tasks on a prototype. The highest-frequency comments of a certain group represent the user's perception of the prototype.

This technique is also applied by Hicks et al. (2018) to analyze the respondents' comments about the juiciness of a game design. The comments are first broken into sentences. Then, similar sentences are grouped. Finally, the sentences that are not fit in any existing groups will be grouped into a new ones. By using the Affinity Diagram, the real thought of the users towards the problematic usability areas of the website can be further analyzed. The developers can know the exact usability problem on the current website to be improved in the future. Also, Widjaja et al. (2013) have created a system called Discusys to aid in producing the Affinity Diagram. Besides, González-Cancelas et al. (2020) used the Affinity Diagram to find out the improvement that should be made in the Spanish port system. Since the Affinity Diagram provides in-depth analysis for the open-ended comments, it is a powerful supplement to the SUS.

METHODOLOGY

Description of the Online Roadshow Website Interfaces

An Online Roadshow website to raise public awareness on COVID-19 was created. The website aimed to educate the participants on COVID-19 and the measures to stop the widespread of the virus. The pages of the Online Roadshow website were the *home page, the main menu, and the game page*. The descriptions of each page are as follows.

Home Page. The home page of the Online Roadshow website is shown in Figure 2. The first page of the Online Roadshow website informed the user about using the Online Roadshow website. When the users scroll down, they will find the general information about COVID-19 and the information on the symptoms of COVID-19 infection. Then, the user must click on the *Proceed to Campaign Page* button at the last section of the page, as shown in Figure 3, to log into the *main menu* of the Online Roadshow website.

Main Menu. After the user logged in, the *main menu* would be displayed as a navigation bar at the top of the page, as shown in Figure 4. The user could browse the entire website using the navigation bar that consists of the link to the *game*, *scoreboard*, *FAQ*, *contact,* and *log out*. The *game* showed all the playable games. There were six games included in the Online Roadshow website, namely *Flappy Bird*, *Brick Breaker*, *Find the Invisible Dog*, *E-motion*, *Voice Control,* and *Pose Matching*. The *scoreboard* displayed the current score of the user for each game. The *FAQ* showed the frequently asked question by the user. The

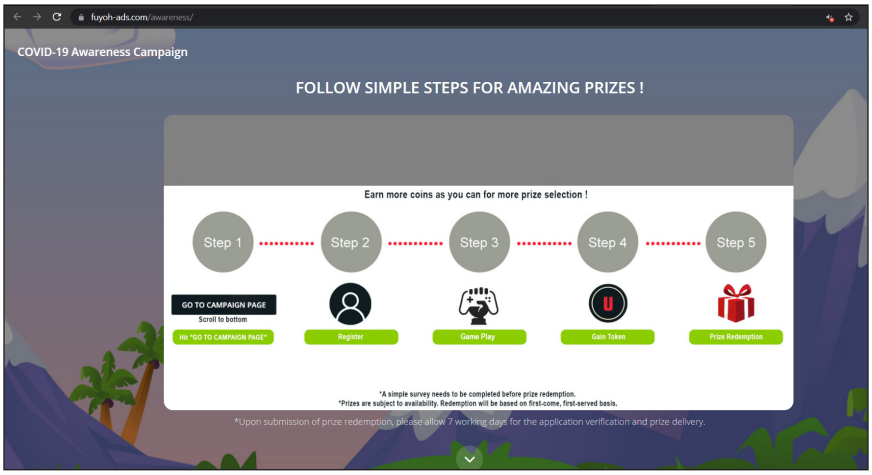


Figure 2. The infographic shows the steps to complete the Online Roadshow

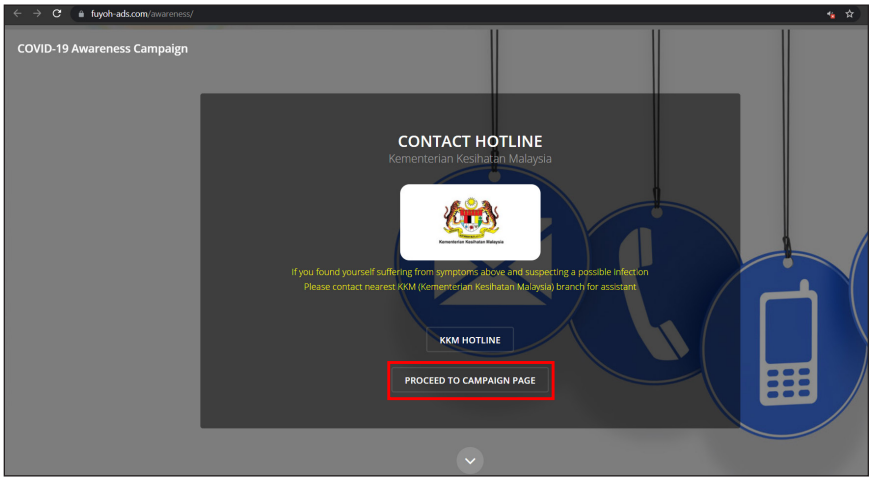


Figure 3. The "Proceed to Campaign Page" button

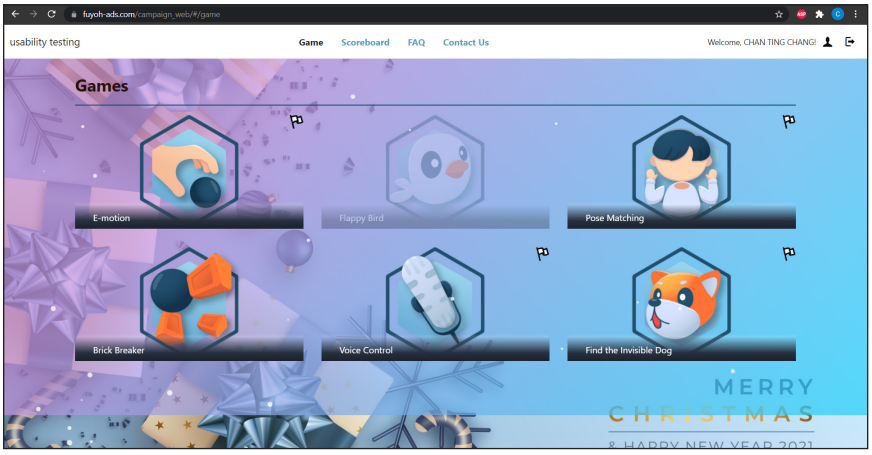
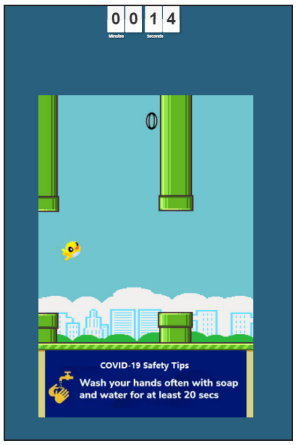


Figure 4. The main menu of the Online Roadshow website

contact us provided a form for the user to write the problems encountered to inform the administrator. The *logout* was for the user to log out from the website.

Game Page. This section explained the rules for each of the games. *Flappy Bird* was a game where the user was required to control the character to fly across pipes, as shown in Figure 5(a). Each tube that the user passed through gave a certain score to the user. Figure



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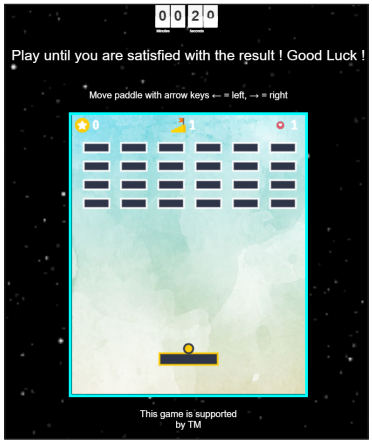

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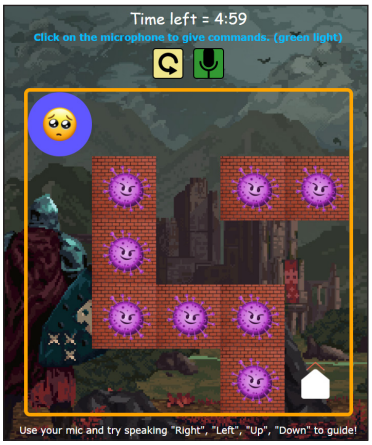

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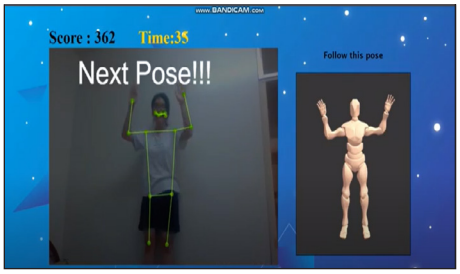

(d)

(e)

(f)

Figure 5. The screenshots for the games

5(b) illustrates the *Brick Breaker* game that required the user to control the moving paddle when the yellow ball shot out to break the bricks, contributing to the score. Figure 5(c) shows the interface of the *Voice Control* game. The user needed to speak the words, such as *up, down, right,* or *left* to control the movements of the lost emoji to reach the home destination, avoiding the viruses. Figure 5(d) shows the *Pose Matching* game in which the user has to mimic the poses displayed in the game to score. It required the user to turn on the camera to capture the user's posture. Next, the *E-motion* game required the user to use the movement of their hand to control the movement of the moving platform to collect objects dropping from the top, as shown in Figure 5(e). Lastly, the user had to move their hand to find the invisible dogs by listening to the barking sound while avoiding the possibility of accidentally capturing a cat by similarly listening to the meowing sound in the *Find the Invisible Dog* game, as shown in Figure 5(f).

Usability Test Procedure

The experiment was performed from 20 December 2020 till 15 January 2021 (27 days) on a group of IT undergraduate students in this pilot test, with at least two years of formal professional IT literacy. The students were in the age range of 18 to 22 years old, who were the most active users in web browsing. First, the users have to log into the website. Then, the users that completed all six games were then led to complete the eleven-questions survey. A total of 106 students completed the survey.

The survey is comprised of two parts, namely the 10-question SUS questions and one open-ended comment. The SUS score for each respondent was calculated for the usability performance of the website. The open-ended comments were then being analyzed using the Affinity Diagram. Long comments from the users were first separated into shorter sentences. From the 106 open-ended comments, some could be split into even smaller sentences as there were a few different major topics covered. As a result, there were a total of 115 distinct comments. Comments on a similar topic were then grouped into one generic category. The grouping process was repeatedly performed on all the comments. The exact comments are represented with the frequency label indicated within a square. Comments of a similar topic were then simplified to be more concise. For example, *positive comments* such as *good*, *well done*, and *good system* were summarized as *Good and Nice*. Then, the *positive comments* that shared the characteristic with other comments, such as *neutral, no, incomplete, and irrelevant comments,* were grouped again re-arranged into the *insufficient information for usability* category. It was done as those comments are the expression of the users towards the website only, lacking information about the usability of the website. Finally, the number of comments for each category was totaled to show their significance, respectively.

RESULT

After obtaining and calculating the SUS scores from 106 participants, the average SUS score for the Online Roadshow website was 58.85. According to section 2.1, the website was evaluated at SUS grade D, with a relatively low usability score. Additional 115 open-ended comments were collected and analyzed via the Affinity Diagram.

Figure 6 shows a portion of all open-ended comments. There was 64 *insufficient information on usability comments,* occupying 55.65% of the total comments. It was followed by 23 *general comments* (20%), 20 *game-related comments* (17.39%), and eight *user-interface-related comments* (7%). The largest number of comments was *insufficient information on usability comments,* while the lowest number of comments was the *user-interface-related comments.*

Figure 7 shows the Affinity Diagram of the *insufficient information on usability comments*. The comments in this category were mostly the expression of the user's overall attitude toward the website without specific details on the well-designed or problematic areas. They were further divided and simplified into several categories, namely *positive*, *neutral*, *no comment*, *incomplete comment*, and *irrelevant,* with the frequency of 12, 6, 40, 2, and 4, respectively. The rectangular box in Figure 7 indicates the aggregated meaning of the comments from the respondents. The most representative comment that expresses the meaning of the similar comments was used as the label for these aggregated groups. *Positive comments* (12) show the highest frequency after *no comment* (40). *Irrelevant comments* (4) show the lowest frequency after *incomplete comments* (2).

The second-largest comments category was the 23 *general comments* (20%). Fourteen descriptive comments mentioned the general problems encountered when browsing the website, while nine prescriptive comments were given on the overall website, as shown in Figure 8. These were general comments that did not specify the precise problematic areas but only provided the general descriptions of problems or suggestions for improvements.

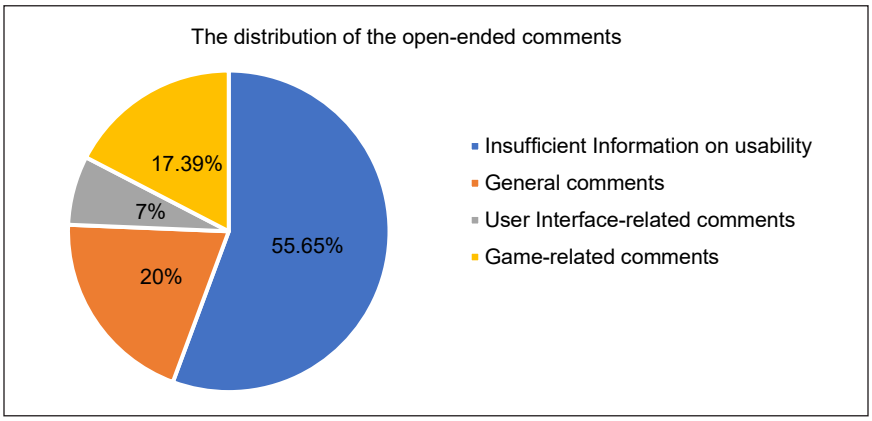

Figure 6. The open-ended comments distribution

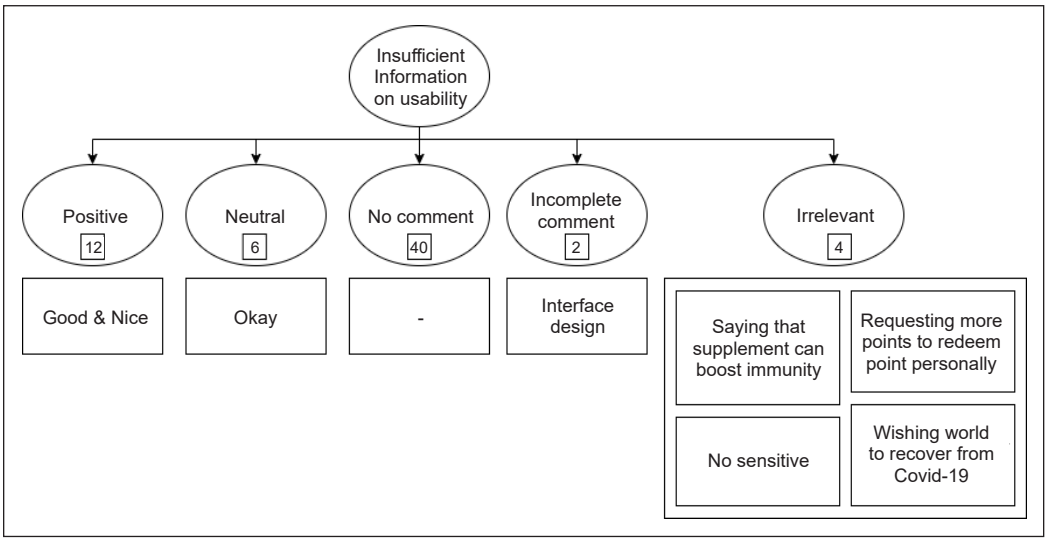

Figure 7. The Affinity Diagram of insufficient information on usability comments

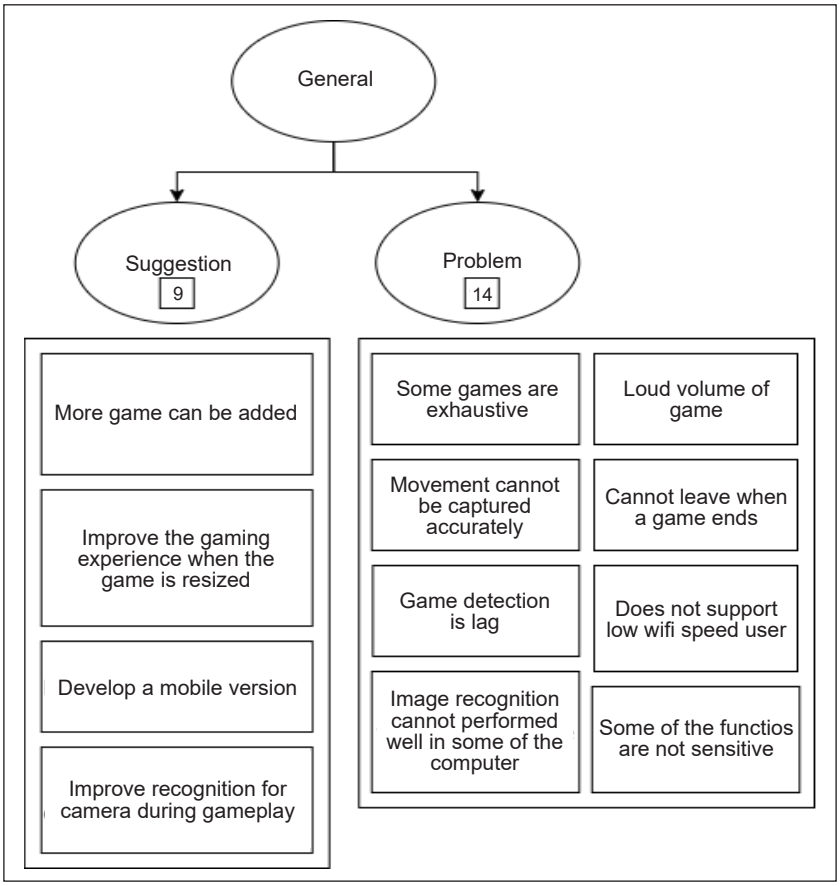

Figure 8. The Affinity Diagram of general comments on the campaign website

Among 23 comments in this category, 14 problems that the user experienced included *exhaustive (exhausting) games, high volume (of game sound) during gameplay, lag in game (camera/microphone) detection, inaccurate movement (pose) capture, unable to leave at the end of the game, discouraging low-speed Wi-Fi user (high loading time for the web pages), insensitive (irresponsive camera/microphone input) functions in the website* and *unsatisfactory performance of image recognition (camera input capturing process) in some computers*. Note that the additional remarks were added in the brackets for a clearer understanding of the comment groups due to the colloquial use of language among the local students. The remaining nine comments provided suggestions to improve the website in general, such as the *development of the mobile version, improvement in camera recognition, the addition of more games,* and *improvement in the gaming experience when the game is being resized*. There were more comments on general problems (14) than general suggestions (9). A lot of the *general comments* were related to the games. Noticeably, one general suggestion requested the mobile version, and one general problem highlighted the network connection problem.

The third and the fourth categories of comments were 20 *game-related comments* (17.39%) and eight *user interface-related comments* (7%). Both categories of comments were highly specific and pinpointed the exact problems that should be solved or specific improvements that should be made. Although both categories had a relatively small number of total comments, these were valuable, constructive comments that provided precise feedback on problematic areas of improvement. In *game-related comments*, the users commented on the exact problems they encountered when playing the games. In *user interface-related comments*, the users pointed out their thoughts about the user interface problems and provided suggestions for improving them.

Figure 9 is the Affinity Diagram of *game-related comments*. There were 20 comments from the respondents in total. It was sorted according to 6 games on the campaign website. There were 2, 3, 4, 1, 6, and 4 comments related to *Flappy Bird, Find the Invisible Dog, Voice Control, Brick Breaker, Pose Matching, and E-motion,* respectively. The *Pose Matching* game had the most feedback from six respondents who commented that the posture was hard to follow. On the other hand, the lowest frequency of the comments was the *Flappy Bird* and *Brick Breaker*, with the issue of malfunctioning scoreboard. Most of the game issues were related to the hardware used in the games, such as the camera image detection procedure and the word recognition procedure of the microphone input. Two non-hardware comments were due to erroneous game mechanics: miss recorded game score and the ability to replay.

Figure 10 is the Affinity Diagram of *user interface-related comments*. There were eight comments from the respondents in total; three discussed the user interface problems, while five of them provided suggestions to improve the campaign website. Among these eight

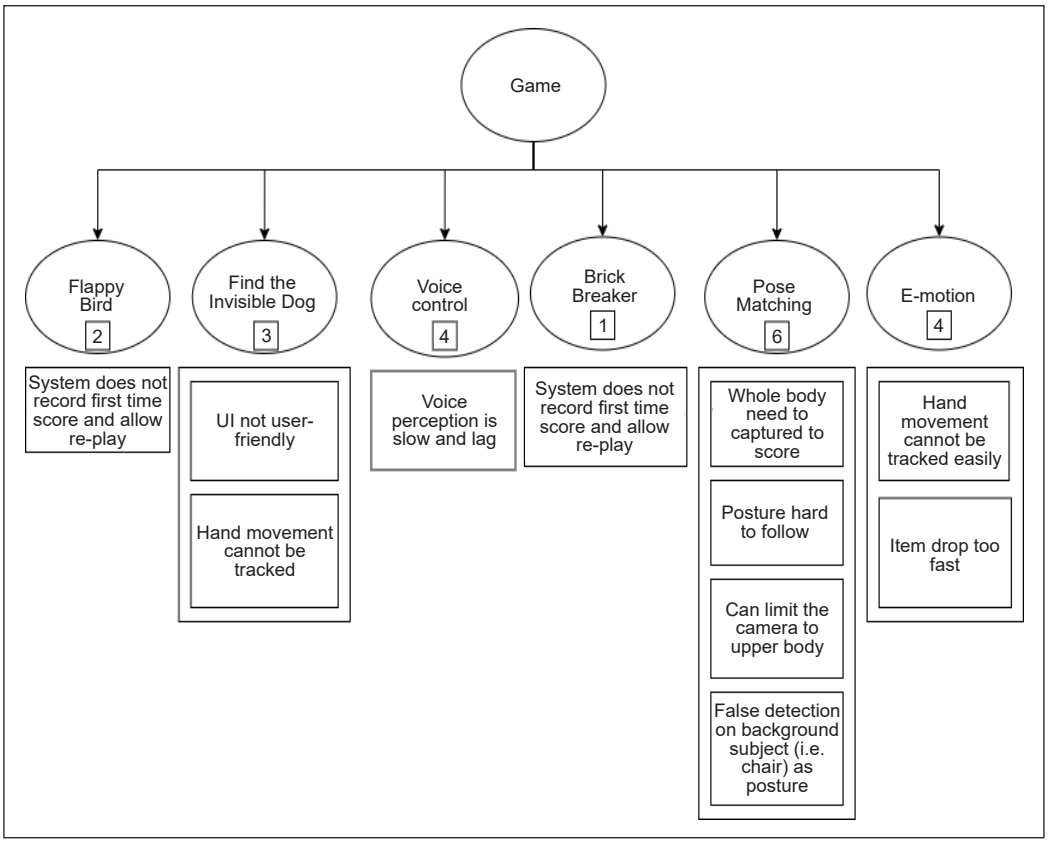

Figure 9. The Affinity Diagram of game-related comments

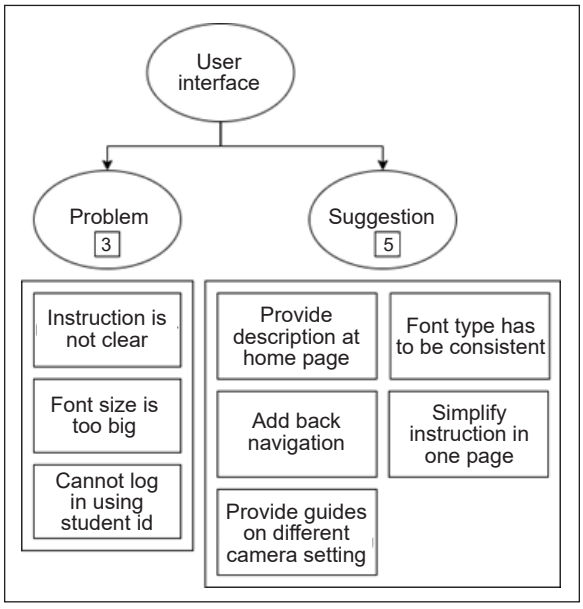

Figure 10. The Affinity Diagram of user interface-related comments

comments, the highest frequency comments discussed the unclear instructions given and the font used on the website. These were the most specific usability issues identified by the respondents.

DISCUSSION AND RECOMMENDATION

The average SUS score of 106 participants is 58.85, which is grade D. The low score of SUS only represents that the browsing experience of the Online Roadshow website did not satisfy the user. However, the subjects that the user did not like on the Online Roadshow website are unknown since the SUS only indicates user satisfaction. Therefore, the additional open-ended comments received from the user are analyzed using the Affinity Diagram to know the problem areas that the user encountered during the browsing activity of the Online Roadshow website. The discussion of the observations of the Affinity Diagram is as follows.

Based on Figure 7, the largest category of the open-ended comments was the *insufficient information on usability comments* in the usability problem analysis of the Online Roadshow website. There were 40 *no comments* in this category, making up the largest group of comments. According to Alhija and Fresko (2009), it is common that approximately half of the respondents are not writing any comment in an open-ended survey. The urge for the respondent to leave a comment is evoked only when there is a powerful impression formed in the respondents' minds from a strong experience. Hence, those comments reflect the weakness of the Online Roadshow website to form a strong user experience since most respondents do not express their thoughts specifically. The second highest frequency further supports it in this category of *positive comments* (12). The significantly lower than the largest frequency, the *positive comments* were ambiguous positive remarks like *good* and *nice*. The rest of the comments (12) in this category were neutral or irrelevant to the usability.

It leads to the second largest category of open-ended comments, which was the *general comments.* As shown in Figure 8, the *general comments* focused on the suggestions and problems for the Online Roadshow website. The result of the *general comments* demonstrated the converging behavior of the open-ended comments towards the problematic usability areas of the analyzed system. These comments showed that the problematic usability areas of the Online Roadshow website were on the games. The low expressivity of the respondents can probably be improved by providing cues to the open-ended question in the survey. Some examples of common usability problems, such as "*font size is too big,*" can be listed in the question to prompt the respondents to express their thoughts more precisely. It is related to the concept of a cue in psychology, where a cue can be any event or stimulus that influences the behavior of the respondents. By providing those examples, cues are given to the respondents, prompting them to give more specific feedback.

The third and fourth portions of the open-ended comments provide information on the specific usability problem for the Online Roadshow website. In the third portion, which is the *game-related comments*, the respondents point out precisely the problems they faced during the gameplay. The *Post Matching* game had more usability issues. It is followed by *E-motion, Voice Control, Find the Invisible Dog, Flappy Bird, and Brick Breaker*. A lot of the issues related to the games were due to hardware dependencies of the system. It was probably due to the cross-platform variations of the hardware used on the individual computer of the participants that may be quite different from those used in the game development. As most of the hardware-dependent games created issues during the interactions, more effort should be made to reinforce the cross-platform implementations of these games. Possible errors that may lead to poor user experience could be caught and handled gracefully to provide a better user experience. The user interface comments highlighted the unclear instructions in a few places in the Online Roadshow website and the inconsistent font use. These were probably the most significant usability issues identified by the respondents for the website in terms of the user interface.

Based on the analysis of the open-ended comments, the identified problematic usability areas were the games (specifically on the hardware-related interaction areas), the unclear instructions, and the inconsistent font uses. The Online Roadshow website was revisited with these areas in mind to identify specific problems highlighted by the respondents. A list of exact usability problems was compiled. Table 2 concludes the usability problems based on the analysis of comments provided by the respondents.

The result of applying the practical usability framework varies for different usability testers. It is caused by the subjective grouping process when producing the Affinity Diagram that depends highly on the analysts. Different analysts may interpret the open-ended comments differently and consequently come out with different Affinity Diagrams. However, the practical framework is universally applicable if the grouping process focuses on identifying the usability problems of the system being tested. The common problematic usability areas will eventually emerge from the further analysis. Hence, using the practical framework, the usability problems of the Online Roadshow website can be identified in a clear view, as shown in Table 2. It showed that the practical framework could assess the usability problems of the website effectively, with just one additional open-ended question, maintaining the simplicity of the SUS.

CONCLUSION

This study used a practical usability assessment framework to evaluate the usability problem of an Online Roadshow website. The new concept website promotes a certain product or a concept to the public. The framework comprises the SUS and the Affinity Diagram to analyze the usability problem of the website. Maintaining the simplicity of the SUS, the one

Table 2
The usability problems of the Online Roadshow website

Problem category	Game/Page	Problems
Game-related issues	Pose-matching	● The entire body should be within the camera view to be recognized by the system. ● Poses were too hard to follow. ● There were false detections in the background, such as recognizing the chair as the body pose.
	E-motion	● Hand movement could not be tracked easily. ● Items in the game dropped too fast to be captured by the hand movement-controlled paddle.
	Voice Control	● Slow and lagging voice perception through the microphone. ● Unclear instructions on the voice-recognition process, like when to start speaking up and stop waiting for the system to process the recognition.
	Find the Invisible Dog	● Hand movement could not be tracked easily. ● The game interface was not user-friendly. There were confusing designs as to what the players should be doing.
	Flappy Bird	● The gameplay score was not recorded. ● There were errors in the game logic, allowing multiple attempts.
	Brick Breaker	● The gameplay score was not recorded. ● There were errors in the game logic, allowing multiple attempts.
User interface-related issues	Main menu & Game rule page	● Unclear instructions were given about the rules and processes.
	Find the Invisible Dog's game rule page	● There were many inconsistencies in font use, including the font types, font colors, and font sizes.
	Login page	● No proper error handling when login errors occurred. No clear instructions on what to do when there were errors.
	All pages	● Back navigation was not provided.
	Home page	● The descriptions were ambiguous and confusing. ● There was no camera setting guide. ● There were many inconsistencies in font use, including the font types, font colors, and font sizes.

additional open-ended comment obtained from the respondents enables the assessment of the usability problem of the system. The Online Roadshow website has a low score in the SUS. By building the Affinity Diagram, the usability problems of the Online Roadshow website can be analyzed and improvised. The proposed framework may be a powerful tool for system designers to evaluate the usability of their systems without conducting a complex heuristic evaluation. The simplicity and elegance of the method are advantageous to those wanting a quick and easy usability test instrument to deal with rapid system development. However, this study has only applied the framework to evaluate the Online Roadshow website. It can be applied to other usability assessments to know its effectiveness in evaluating the usability problems to assess the reliability of the proposed framework.

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