Usability of Lampung Heritage Virtual Reality Tour

Sony Ferbangkara[1,*], Mardiana[1], F.X. Arinto[1], Sri Ratna Sulistiyanti[1], and Khairudin[1], Wahyu Eko Sulistiono[1], Meizano Ardhi Muhammad[1]

[1]*Department of Electrical Engineering, University of Lampung, Jl. Soemantri Brojonegoro no, 1 Bandar Lampung 35145 Indonesia*

[*]*Email: sony@staff.unila.ac.id*

Article Information:

Received:
25 August 2022

Received in revised form:
21 November 2022

Accepted:
17 December 2022

Volume 4, Issue 2, December 2022
pp. 61 – 66

© Universitas Lampung

https://doi.org/10.23960/jesr.v4i2.110

Abstract

Lampung Heritage Virtual Reality Tour was developed as a tool to educate the importance of Lampung's historical heritage. It represents eight Lampung historical heritage sites in the virtual reality world, namely the Lampung Museum, Thay Hin Bio Vihara, Al-Anwar Mosque, Lampung Siger Tower, Krakatau Monument, Kerti Bhuana Temple, Nuwo Sesat Traditional House, and the Japanese Caves. Functional features of the Lampung Heritage Virtual Reality Tour are visiting virtual tourist spots and viewing information on virtual tourist attractions. Digital tourists can select a virtual tourist spot with the location panel. The user perception and satisfaction require a qualitative measurement to understand its impact on educating Lampung's historical heritage. Using usability, we should understand the quality of the Lampung Heritage Virtual Reality Tour. The tools to measure the usability level of the application are the User Acceptance Test and the System Usability Scale. There were 15 questions User Acceptance Test (UAT) with a composition of five questions affordance, four questions signifier, and six questions feedback. According to the SUS standard, we asked ten questions on the System Usability Scale (SUS). The result for UAT was an average of 95.75%, which consist of 95.00% affordance, 94.79% signifier, and 97.45% feedback. The result of SUS was Good, based on a score of 83.39. The Lampung Heritage Virtual Reality Tour meets good usability standards, making the application suitable.

Keywords: *virtual reality tour, Lampung historical heritage, usability, SUS, UAT*

I. INTRODUCTION

Virtual Reality technology was used to deliver information because it can immerse viewers in a world that combines fiction and reality [1]. Virtual reality allows users to interact and consume data from the virtual world[2]. It is a tool for learning in an immersive environment [3].

The Lampung Heritage Virtual Reality Tour was developed in 2021 to help Lampung Museum disseminate information about the historical heritage in Lampung Province [4], [5]. It enables the tourist to visit the attraction and interact for details in virtual reality. It uses Gaze Input Control and is implemented on the Android platform using Google Cardboard to allow easier implementation by the general public[6]. Moreover, virtual reality technology for learning enables the general public, especially millennial children or students who want to learn, to visit these locations without traveling to historical sites in Lampung [7]. The experience transports the user into reality-simulated and hypothetical environments [8].

We need to measure usability to understand virtual reality technology's benefits [9]. There are several tools to measure usability, such as User Acceptance Test (UAT) and System Usability Scale (SUS)[10]. Therefore, The Lampung Heritage Virtual Reality Tour requires investigation of usability to understand its usefulness and further improvisation and research directions.

II. MATERIALS AND METHODS

The user perception and satisfaction require a qualitative measurement to understand the Lampung Heritage Virtual Reality Tour's impact on educating

Lampung's historical heritage to the public. Therefore, usability evaluation was the central theme of the research. The evaluation must be done in the field because the target is the general public. It will allow an undisrupted user experience, so the user can express usability more organically when evaluated. The Lampung Heritage Virtual Reality Tour is a functional prototype, so users' experience is close to the final system. The tools to measure the usability level of the application are the User Acceptance Test (UAT) and the System Usability Scale (SUS).

A. User Acceptance Test (UAT)

There are three categories of usability: effectiveness/affordance, efficiency/signifier, and appreciation/feedback [11], [12]. The focus on measurement is on activities carried out by [13]. Furthermore, under ISO/IEC 25010, usability is measured based on the context of use (in-use metrics) [14].

There were 15 questions User Acceptance Test (UAT) with a composition of five questions affordance, four questions signifier, and six questions feedback divided into three groups. Every question is given a code for easy reference. The questions are as follows:

1. Effective (affordance):
    a. Representation of attractions displayed in Virtual Reality (UATA1)
    b. Presentation of information as needed (UATA2)
    c. The information presented can be trusted (UATA3)
    d. Virtual reality is effective as a medium for the introduction of ecotourism (UATA4)
    e. Virtual reality is effective as a medium for conducting ecotourism (UATA5)
2. Efficient (signifier)
    a. Menu makes it easy to use the application (UATS1)
    b. VR devices used for virtual reality feel comfortable (UATS2)
    c. Virtual reality is quite fast to respond (UATS3)
    d. The objects displayed are reasonable and represent the original (UATS4)
3. Appreciation (Feedback)
    a. VR app interactions are easy to understand (UATF1)
    b. Become more interested in ecotourism because of VR (UATF2)
    c. Finding information using VR is easy (UATF3)
    d. Want to continue using VR apps (UATF4)
    e. Would like to recommend others to use VR (UATF5)
    f. Overall satisfying VR app (UATF6)

The score scale for each question in the evaluation questionnaire is set in Table 1.

Table 1. The scale of the UAT Assessment

No.	Statement	Weight
1	Strongly disagree	0
2	Disagree	1
3	Agree	2
4	Strongly agree	3

B. System Usability Scale (SUS)

UX evaluation on usability using the System Usability Scale (SUS) [10]. SUS can measure usability relevant to actual conditions [15]. There are ten questions on the SUS, which are measured using a scale of 0-100. Scores above 68 are considered above average, while scores below 68 are considered below average. A Likert scale is utilized to facilitate the assessment by dividing the range into six parts: 0, 20, 40, 60, 80, and 100. The even distribution aims to skew user ratings to one pole, negative or positive.

There are ten questions in SUS divided into two categories. First, the positive parameters category is in odd numbers: 1, 3, 5, 7, and 9. The second category is negative parameters in even numbers: 2, 4, 6, 8, and 10.

The SUS questions were as follows:

1) I often want to use Virtual Reality Tour to learn about Lampung's heritage. (SUS01)
2) I feel Lampung Heritage Virtual Reality Tour is complicated. (SUS02)
3) I think Lampung Heritage Virtual Reality Tour is easy to use. (SUS03)
4) I need support from a technical person to use this Lampung Heritage Virtual Reality Tour. (SUS04)
5) I found that the various functions of this Lampung Heritage Virtual Reality Tour are well integrated. (SUS05)
6) I think there are too many inconsistencies in this Lampung Heritage Virtual Reality Tour. (SUS06)
7) I imagine that most people will learn to use this Lampung Heritage Virtual Reality Tour very quickly. (SUS07)
8) I find Lampung Heritage Virtual Reality Tour very difficult to use. (SUS08)
9) I feel very confident using Lampung Heritage Virtual Reality Tour. (SUS09)
10) I need to learn many things before I can use this Lampung Heritage Virtual Reality Tour. (SUS10)

The SUS scale is the Adjective Rating Scale for SUS, shown in Table 2 [16].

Table 2. SUS *Adjective Rating Scale*

Adjective	Mean	Standard Deviation
Worst Imaginable	12.05	13.01
Awful	20.03	11.03
Poor	35.07	12.06
OK	50.09	13.08
Good	71.04	11.06
Excellent	85.05	10.04
Best Imaginable	90.09	13.04

III. RESULTS AND DISCUSSIONS

VR Evaluation based on the UX Framework for VR[17], evaluation is carried out on the main category Measurement (Measurement) with sub-category Exclusive Subjective, Measure (Measurement Method) with sub-category Exclusive Qualitative, Evaluator (VR Assessor) with sub-category User (User), Location (Location) with sub-category Field (Field Test), System Development Phase (Stage Development) with sub-category Functional Prototype, and Period of Experience (Period of VR experience) with sub-category After use (Episodic UX).

A. User Acceptance Test (UAT)

The results of the User Acceptance Test (UAT) Evaluation of the user have a total response received, namely 72 participants with 15 questions.

From the total affordance questions (Figure 1), the responses were 40.00% Strongly Agreed, 55.00% agreed, 5.00% disagreed, and 0% strongly disagreed. Therefore, affordance was agreed upon by 95% of the participants.

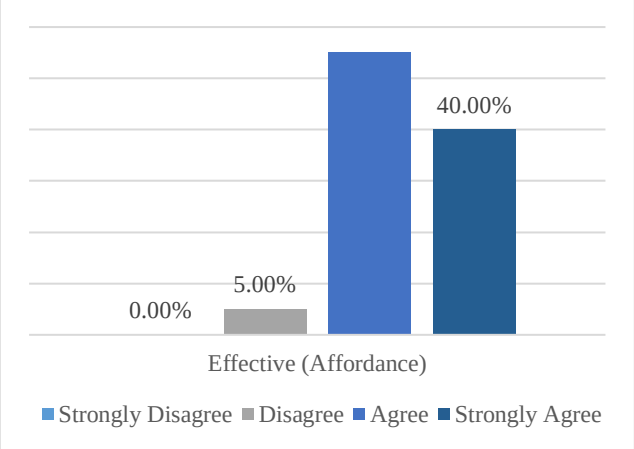

Figure 1. *Affordance Evaluation*

From the total signifier questions responses (Figure 2), 39.93% strongly agreed, 54.86% agreed, 2.78% disagreed, and 2.43% strongly disagreed. Therefore, the participant supported the signifier by the 94.79% Agreed statement.

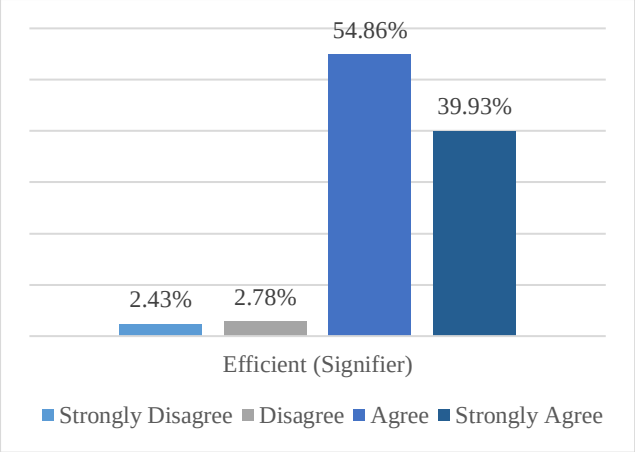

Figure 2. *Signifier Evaluation*

From the total feedback questions responses (Figure 3), 54.86% strongly agreed, 42.59% agreed, 2.55% disagreed, and 0.00% strongly disagreed. Therefore, the participants approved feedback by 97.45%. Can be seen in the following image:

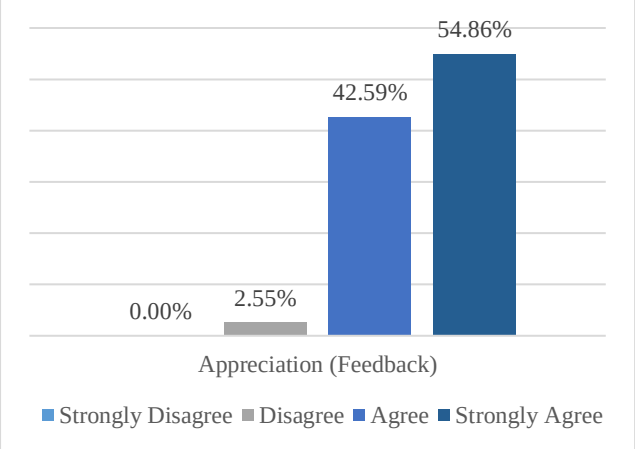

Figure 3. Feedback Evaluation

The total score for each question according to a predetermined scale into 4 points of assessment is shown in

Table 3.

Table 3. UAT Evaluation Score

Criteria	Score				Score	Std Dev	Error Rate
	0	1	2	3			
Effective (affordance)	0	18	198	144	360	83.46	41.73
Efficient (Signifier)	7	8	158	115	288	66.27	33.13
Appreciation (Feedback)	0	11	184	237	432	104.27	52.14
Total	7	37	540	496	1080	248.71	124.36

The highest score is Agree, as much as 50.83%, with a total response of 540 responses from 72 participants. The second highest score strongly agreed as much as 45.93%, with a total response of 496. Then for a scale of 1 or disagree, it has 3.43%, which is 37 responses. Furthermore, a scale of 0 or strongly disagrees has a response of 0.65% of 7 responses. The average percentage of participants' approval of the UAT was 95.75%. Figure 4 shows the results of the UAT evaluation.

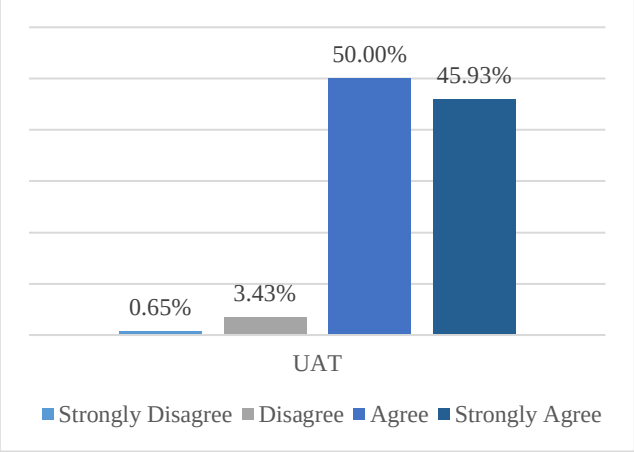

Figure 4. UAT Evaluation

B. System Usability Scale (SUS)

The SUS assessment score scale for each question in the evaluation questionnaire can are shown in Table 4.

Table 4. System Usability Scale (SUS) Mapped to Likert

No.	Weight	Statement
1	0	Strongly Disagree
2	20	Disagree
3	40	Slightly Disagree
4	60	Slightly Agree
5	80	Agree
6	100	Strongly Agree

There are 72 participants for SUS. The evaluation results of the Lampung Heritage Virtual Reality Tour are shown in Table 5. Numbers 1, 3, 5, 7, and 9 are positive parameter questions, and numbers 2, 4, 6, 8, and 10 are negative parameter questions. The tendency of users to positively rate the experience of UX Lampung Heritage Virtual Reality Tour, where negative ratings tend to be small.

Table 5. UX Lampung Heritage Virtual Reality Tour Evaluation results

SUS	0	20	40	60	80	100	Total	Mod	Avg	Err
SUS01	0	3	4	2	30	33	72	100	83.89	2.41
SUS02	23	40	3	3	3	0	72	20	18.61	2.23
SUS03	0	4	3	3	35	27	72	80	81.67	2.45
SUS04	26	36	5	2	3	0	72	20	17.78	2.24
SUS05	0	4	2	2	28	36	72	100	85.00	2.45
SUS06	31	32	4	3	2	0	72	20	15.83	2.19
SUS07	0	1	4	5	29	33	72	100	84.72	2.13
SUS08	30	35	2	3	2	0	72	20	15.56	2.12
SUS09	0	2	3	6	28	33	72	100	84.17	2.25
SUS10	34	30	4	2	2	0	72	0	14.44	2.12
Total	**144**	**207**	**74**	**91**	**242**	**262**	**720**	**20**	**50.17**	**2.26**

Based on the category of questions with positive parameters, the UX Evaluation on Lampung Heritage Virtual Reality Tour results is shown in

Table 6. The average assessment of the positive parameters is above 68, which means that the UX

quality of the Lampung Heritage Virtual Reality Tour is above average.

Table 6. UX Lampung Heritage Virtual Reality Tour on positive parameters Evaluation results

SUS	0	20	40	60	80	100	Total	Mod	Avg	Err
SUS01	0	3	4	2	30	33	72	100	83.89	2.41
SUS03	0	4	3	3	35	27	72	80	81.67	2.45
SUS05	0	4	2	2	28	36	72	100	85.00	2.45
SUS07	0	1	4	5	29	33	72	100	84.72	2.13
SUS09	0	2	3	6	28	33	72	100	84.17	2.25
Total	**0**	**34**	**56**	**78**	**230**	**262**	**360**	**100**	**83.89**	**2.34**

Based on the category of questions with negative parameters, the results of the UX Evaluation on the Lampung Heritage Virtual Reality Tour are shown in Table 7. The average assessment of the negative parameters is below 68, meaning there are no significant complaints against the UX Lampung Heritage Virtual Reality Tour.

Table 7. UX Lampung Heritage Virtual Reality Tour on negative parameters Evaluation results

SUS	0	20	40	60	80	100	Total	Mod	Avg	Err
SUS02	23	40	3	3	3	0	72	20	18.61	2.23
SUS04	26	36	5	2	3	0	72	20	17.78	2.24
SUS06	31	32	4	3	2	0	72	20	15.83	2.19
SUS08	30	35	2	3	2	0	72	20	15.56	2.12
SUS10	34	30	4	2	2	0	72	0	14.44	2.12
Total	**144**	**193**	**58**	**73**	**92**	**100**	**360**	**20**	**16.44**	**2.18**

Based on a positive point of view, the UX Evaluation score is 83.72, meaning the UX quality is above average. Meanwhile, on the contrary, the negative point of view on UX tends to be small, namely, 16.28, which means it is not enough to provide a bad experience for the user. Evaluation of UX Virtual Reality Tour for Ecotourism based on the question parameter categories is shown in Table 8.

Table 8. Evaluation of UX Lampung Heritage Virtual Reality Tour by category of question parameters

SUS	Positive	Negative	Error Rate
SUS01	83.89	16.11	2.41
SUS02	81.39	18.61	2.23
SUS03	81.67	18.33	2.45
SUS04	82.22	17.78	2.24
SUS05	85.00	15.00	2.45
SUS06	84.17	15.83	2.19
SUS07	84.72	15.28	2.13
SUS08	84.44	15.56	2.12
SUS09	84.17	15.83	2.25
SUS10	85.56	14.44	2.12
Total	**83.72**	**16.28**	**2.26**

The presentation of data in the form of bar graphs with opposite polarities between positive and negative parameters indicates that positive ratings tend to be much larger than negative ratings. The data follows the average positive rating of 83.89, which is far above the average negative rating of 16.44. To show the gap difference between positive and negative parameters, The Lampung Heritage Virtual Reality Tour UX Evaluation Two-Way Bar Chart is shown in Figure 5.

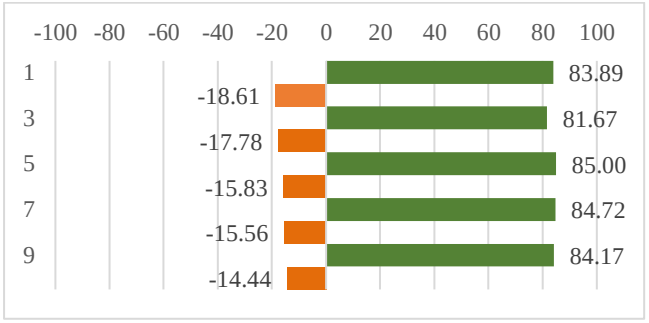

Figure 5. Lampung Heritage Virtual Reality Tour UX Evaluation Two-Way Bar Chart

C. Discussion

The result of UAT shows a strong correlation with the outcome of SUS. There are no discrepancies between

affordance, signifier, and feedback score on UAT. The SUS result for every positive parameter did not stray far from the average value of 83.89. Even when we see the question parameter based on the question parameter category, including the negative parameter, it still averages 83.72. With 50.83% agree and 45.93% strongly agree, summed as 96.76%, UAT was comparable with the SUS score of 83.89. This shows general usability of the Lampung Heritage Virtual Reality Tour is acceptable.

IV. CONCLUSIONS

The result for UAT was an average of 95.75%, which consist of 95.00% affordance, 94.79% signifier, and 97.45% feedback. Moreover, the result of SUS was classified as good, with a score of 83.89. Therefore, the Lampung Heritage Virtual Reality Tour meets good usability standards, making the application suitable.

V. ACKNOWLEDGMENT

The authors gratefully acknowledge the contributions of the Mixed Reality Research Group University of Lampung in implementing technology. DIPA BLU Unila Innovation Research Grant supports this research by the Research and Community Service University of Lampung. Moreover, the study is also part of the Capstone Project from PUI-PT Green Technology University of Lampung.

VI. REFERENCES

[1] K. Yin, Z. He, J. Xiong, J. Zou, K. Li, and S.-T. Wu, "Virtual reality and augmented reality displays: advances and future perspectives," *J. Phys. Photonics*, vol. 3, no. 2, p. 022010, Apr. 2021, doi: 10.1088/2515-7647/abf02e.

[2] R. Skarbez, M. Smith, and M. C. Whitton, "Revisiting Milgram and Kishino's Reality-Virtuality Continuum," *Front. Virtual Real.*, vol. 2, p. 647997, Mar. 2021, doi: 10.3389/frvir.2021.647997.

[3] T. Mazuryk and M. Gervautz, "Virtual Reality History, Applications, Technology and Future," *VIRTUAL REALITY*, p. 72.

[4] U. Hartati, "Museum Lampung sebagai Media Pembelajaran Sejarah," *HISTORIA*, vol. 4, no. 1, pp. 1–10, 2016.

[5] W. E. Sulistiono *et al.*, "Virtual Reality as Learning Media for Lampung Historical Heritage," in *2021 International Conference on Converging Technology in Electrical and Information Engineering (ICCTEIE)*, Bandar Lampung, Indonesia, Oct. 2021, pp. 14–18. doi: 10.1109/ICCTEIE54047.2021.9650626.

[6] J.-H. Lo, S.-D. Wu, and M.-J. You, "Interactive Virtual Reality Touring System: A Case Study of Shulin Ji'an Temple in Taiwan," *Mobile Information Systems*, vol. 2021, pp. 1–15, Aug. 2021, doi: 10.1155/2021/6651916.

[7] C. Koo, J. Park, and J.-N. Lee, "Smart tourism: Traveler, business, and organizational perspectives," *Information & Management*, vol. 54, no. 6, pp. 683–686, Sep. 2017, doi: 10.1016/j.im.2017.04.005.

[8] J. Motejlek and E. Alpay, "A Taxonomy for Virtual and Augmented Reality in Education," Copenhagen, Sep. 2018, p. 12. [Online]. Available: https://arxiv.org/abs/1906.12051

[9] H. T. Chong, C. K. Lim, M. F. Ahmed, K. L. Tan, and M. B. Mokhtar, "Virtual Reality Usability and Accessibility for Cultural Heritage Practices: Challenges Mapping and Recommendations," *Electronics*, vol. 10, no. 12, p. 1430, Jun. 2021, doi: 10.3390/electronics10121430.

[10] John Brooke, "SUS: A Retrospective," *JUS*, vol. 8, no. 2, pp. 29–40, Feb. 2013.

[11] M. De Paiva Guimaraes and V. F. Martins, "A Checklist to Evaluate Augmented Reality Applications," in *2014 XVI Symposium on Virtual and Augmented Reality*, Piata Salvador, May 2014, pp. 45–52. doi: 10.1109/SVR.2014.17.

[12] D. Norman, *The Design of Everyday Things*. Vahlen, 2016. doi: 10.15358/9783800648108.

[13] V. Thomas, C. Remy, and O. Bates, "The Limits of HCD: Reimagining the Anthropocentricity of ISO 9241-210," in *Proceedings of the 2017 Workshop on Computing Within Limits*, Santa Barbara California USA, Jun. 2017, pp. 85–92. doi: 10.1145/3080556.3080561.

[14] M. Speicher, "What is Usability? A Characterization based on ISO 9241-11 and ISO/IEC 25010," *arXiv:1502.06792 [cs]*, Feb. 2015, Accessed: Apr. 01, 2022. [Online]. Available: http://arxiv.org/abs/1502.06792

[15] S. C. Peres, T. Pham, and R. Phillips, "Validation of the System Usability Scale (SUS): SUS in the Wild," *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, vol. 57, no. 1, pp. 192–196, Sep. 2013, doi: 10.1177/1541931213571043.

[16] A. Bangor, "Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale," vol. 4, no. 3, p. 10, 2009.

[17] Y. M. Kim, I. Rhiu, and M. H. Yun, "A Systematic Review of a Virtual Reality System from the Perspective of User Experience," *International Journal of Human–Computer Interaction*, vol. 36, no. 10, pp. 893–910, Jun. 2020, doi: 10.1080/10447318.2019.1699746.