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QoE Analysis of Open Access Network at the University of Riau

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***Abstract*— This journal outlines a QoE network analysis conducted through both subjective and objective methods. The subjective approach involved the distribution of questionnaires via Google Forms to Riau University students using open access network, while the objective method utilized open access network in the Engineering Faculty Lobby and the Riau University Library, facilitated by the Google LightHouse tool. This analysis extended over a span of five days, encompassing morning, afternoon, and evening measurements, focusing on five web-based applications: YouTube, Facebook, WhatsApp, Instagram, and the Riau University Portal. The parameters assessed included Performance, Accessibility, Best Practices, and SEO. The QoE measurement results were presented in both tabular and graphical formats. The subjective method yielded a MOS value of 3.45, classifying it as "quite good." Meanwhile, when using the objective method in the open access network in the Lobby of the Faculty of Engineering, the average performance was 46.86, placing it in the "bad" category. In the UNRI Library location, the average performance was 48.2, also categorized as "bad." However, for other parameters, the average scores exceeded 50, falling into the "Fair" and "Good" categories.**

***Keywords*— Application, Google LightHouse Mos, QoE, Subjektif, Objektif, Parameter**

I. INTRODUCTION

The development of the internet around the world has opened up various opportunities for everyone, including in the world of education. The internet is not only used to provide scientific and academic information but also as part of the concept of educational technology to facilitate the teaching and learning process [1]. Riau University, one of the largest campuses in Riau, has provided internet access for students, lecturers, and staff. Internet networks are available in various faculties at Riau University. In addition, to support education, the campus also provides an open access network that can be accessed without requiring a password. What is meant by an open access network is a network that can be accessed by students and lecturers without requiring a password. Students and lecturers can access the internet through smartphones or computers, including websites and web-based applications. The author has distributed questionnaires through Googel Form to UNRI students with the question of what applications are often used by UNRI students. Then the results of applications that are often used are Youtube, WhatsApp, Facebook, Instagram, and UNRI Portal. Therefore, when accessing the network, user satisfaction needs to be considered. User satisfaction can be assessed by quality of experience (QoE) [2]. QoE mainly focuses on multimedia applications and network communications; people put those who use internet products in the role of users [3]. Quality of experience is the subjective acceptability of the quality of a telecommunication service perceived by the user. This contrasts with quality of service, which concerns objective and technical metrics at network and application level [15]. To measure the level of QoE in this case, human judgment can be used. Opinion score average (MOS) is an abundance measure used to assess the quality of media signals [4]. QoE can also be an objective perspective, i.e., with measurement methods using technical measuring instruments. An example is measuring the speed of response time, error rate, and buffering time while watching a video. QoE objectively shows more real and accurate results because it is not influenced by the results of human perception [5]. In research conducted on measuring quality of experience objectively with the title "Network Performance Criteria for Telecommunication Traffic Types Driven by Quality of Experience [6]", researchers who conducted research related to service provider turnover chose user perceptions of the service. Quality of experience (QoE) describes the end user's perception of the service when using it. The researchers defined it using a testbed. Measurements that explore the impact of packet loss and delay on user QoE for video, voice, and management traffic Next is a study entitled "Monitoring Quality of Experience in Mobile Networks from End Devices. [7]. The researchers addressed the issue of providing QoE in smart phones from a dual perspective, combining results obtained from subjective laboratory tests with passive measurements of end devices and user-sourced QoE feedback obtained in operational cellular

networks. Research conducted by [8] In this study, a Quality of Experience (QoE)-driven cross-layer resource allocation scheme for high-traffic services over a downlink open wireless network (OWN) is proposed. The simulation results of this study show that the proposed scheme over OWN can provide a higher average MOS for the whole system compared to other algorithms. The research conducted by [9] utilizes two metrics: PSNR given in dB (values in the range of 0 to 100 on the right-hand side) and SSIM with values in the range of 0 to 1 (on the left-hand side). Based on the PSNR/MOS mapping and the metric values obtained, it can be concluded that the video quality is satisfactory if the PSNR value is above 37 dB or the SSIM value is above 0.9.
In this study, the quality of the open access network at Riau University was measured using the QoE method subjectively and objectively, so as to obtain optimal QoE results using subjective methods by distributing questionnaires to students who use open network access via Google Form. In addition, objective measurements are made using Google Lighthouse.

II. METHODOLOGY

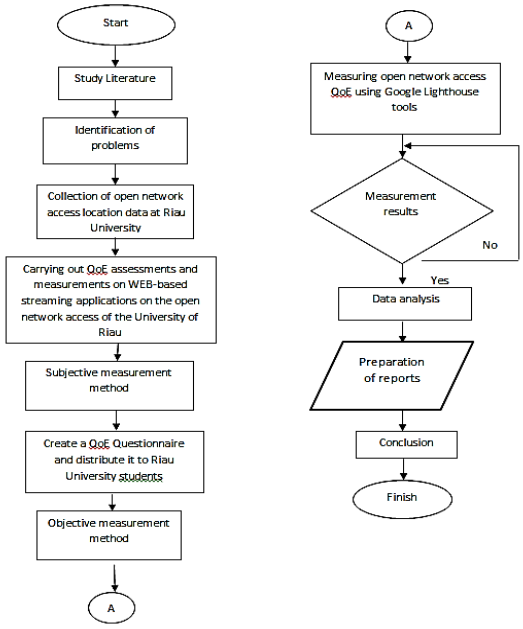

Fig.1. Flowchart

A. *Subjectify Method*

This measurement method involves user participation in the measurement process [10]. Users are asked to provide feedback about the quality of their user experience using a particular service or application. For research on quality of experience (QoE), mean opinion scores (MOS) are widely chosen as the results of subjective tests and the ground-truth reference for further research on objective quality modeling. Furthermore, the results of objective quality modeling are used for QoE management subsequently [14]. Classification is necessary to understand each concept. QoE is not an exception. We classify this concept into three different classes: QoE as an extension of QoS, QoE for management systems, and QoE as a hedonistic concept [11]. We chose this classification method because these three approaches can cover the entire concept of QoE.

TABLE I. MEAN OPINION SCORE (MOS) CATEGORY

No	Category	Score
1	Bad	1
1	Poor	2
2	Fair	3
3	Good	4
4	Excellent	5

Mean Opinion Score (MOS) is a method of measuring voice quality in communication systems that is calculated based on user ratings in a scale range of 1 to 5, where a value of 5 indicates excellent voice quality. To calculate the MOS average, add up all the MOS ratings obtained from the various respondents and divide the result by the number of ratings available. Experience is an experience aimed at customers or users regarding a service provided by a service provider. The QoE parameters are as follows:

- Quality Of Effectiveness. This is a traditional approach dimension of Quality of Effectiveness that is directly related to the accuracy and performance of technology at four levels, namely applications or network services and hardware.
- Usability. Usability focuses on ease of work, user-friendliness, and human-computer interaction.
- Quality Of Efficiency. This dimension aims to complement subjective characteristics and Quality of Experience, Quality of Efficiency is divided into three levels, namely hardware, network, and applications or services.
- Expectation. There is a conceptual way to be able to measure the subjective dimensions of Quality of Efficiency correctly.
- Context. It is a consideration of experience in a wider range. There are five types of context in this dimension, namely individual or social environmental, cultural, technological, and organizational. The desires that users have depend on the context they define for themselves [12].

B. *Objektif Methode*

This measurement method is carried out by direct measurement using Google Lighthouse tools with several parameters, including performance, accessibility, best practices, and SEO. The following is the range of Google Lighthouse categories [13].

TABLE III. RANGE GOOGLE LIGHTHOUSE CATEGORY

No	Category	Score
1	Bad	0-49
2	Fair	50-89
3	Good	90-100

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III. Result And Discussion

The subjective and objective Quality of Experience (QoE) measurements were conducted on the open network access at Riau University, which is located in two places: the open network access in the Faculty of Engineering Lobby and the University Library. For this measurement, we utilized a tool, namely Google Lighthouse, on a laptop.

A. *Results and Discussion of Subjective QoE Measurements*

In this subjective measurement, data was obtained by distributing questionnaires via Google Form, which were distributed to several Riau University students who used open network access, especially those located in the Faculty of Engineering Lobby and the UNRI Library. Table 3 is data from the results of distributing the questionnaire.

TABLE IIIII. QUESTIONNAIRE RESPONDENT DATA

No	Faculty	Class of	Total
1	Engineering	2018 - 2021	67
2	Mathematics and science	2019	1
3	Fisheries faculty	2020	29
4	Agriculture	2019	3
5	Teacher Training and Educations	2020	2

Table III, it can be concluded that the majority of questionnaire respondents were engineering faculty students who used open-service access in the engineering faculty lobby. This happened because many of the engineering faculty-student respondents were at the engineering faculty location. Meanwhile, other faculties are respondents to the UNRI library. The following is data from the user experience of accessing the open network at Unri according to the sub-variables of QoE. Table IV displays the average MOS score obtained for each question given in the questionnaire distributed to students who access the open network. Equation (1) is the formula to obtain the average score for every question.

$$Average = \left(\sum_{k=1}^{n}(\mathrm{k} * \mathrm{s})\right)/R \quad (1)$$

Where: k is the scale of MOS, ranging from 1 to 5, s is the number of participants choosing the certain scale for the question, and R is the total number of participants, which is a hundred. For instance, here is the average for the question number 1.

$$Average = \frac{\sum_{k=1}^{5} k\ x\ s}{100}$$

$$Average = \frac{(0x1) + (2x9) + (3x58) + (4x32) + (5x1)}{100}$$

$$Average = \frac{0 + 18 + 174 + 128 + 5}{100} = 3{,}25$$

TABLE IVV. QUESTIONNAIRE RELATED TO EXPERIENCE IN USING OPEN ACCESS NETWORKS AT UNIVERSITAS RIAU

Item	Scale					Total	Average
	1	2	3	4	5		
How often do you use open network access services at Riau University?	0	9	58	32	1	100	3.25
Does the open network access service at Riau University have a good response time?	0	10	79	11	0	100	3.01
Is the open network access server at Riau University operational all the time?	0	4	15	27	54	100	4.31
How often do you experience connectivity interruptions or failures when using open access network services on campus?	2	12	70	16	0	100	3
Is the open network access service at Riau University functioning well?	0	8	86	6	0	100	2.98
Does the open network access service at Riau University give users freedom to use the service?	0	3	25	23	49	100	4.18
Does the use of open network access services at Riau University meet your needs?	0	3	45	15	37	100	3.86
How easy is it to log in when accessing the open network at Riau University?	0	12	73	15	0	100	3.03
Don't users need to use additional devices to be able to use open network access services at Riau University?	0	1	20	17	62	100	4.4
Can open network access services at Riau University be accessed at any time?	0	7	21	31	41	100	4.06
Can open network access services be accessed from anywhere?	20	56	24	0	0	100	2.04
Can the open network access service at Riau University be used outdoors or indoors?	8	58	23	6	5	100	2.42
Is the open network access service at Riau University able to provide good service for users?	2	9	76	12	1	100	3.01
Can the open network access services at Riau University be used by all ages?	0	1	15	17	67	100	4.5
Can open network access services at Riau University be accessed via various user devices?	0	3	19	14	64	100	4.39
What is your experience in using open access services at Riau University?	0	10	74	16	0	100	3.06

B. *Results and Discussion of Objective QoE Measurements*

In general, all measurements for applications and portals conducted using Google Lighthouse Tools have shown poor performance results, with scores below 50 [13]. These measurements were carried out over five days, from 08:00 AM to 05:00 PM WIB, at two locations: the Faculty of Engineering Lobby and the Library at UNRI. The daily measurements were subdivided into morning measurements from 08:00 AM to 11:00 AM, midday measurements from 12:00 PM to 02:00 PM, and afternoon measurements from 03:00 PM to 05:00 PM WIB. The average results for each parameter were as follows: Performance 46.86 and 48.2, categorized as "Bad performance"; Accessibility parameters 75.26 and 80.8, categorized as "Fair performance"; Best Practices 85 and 82.73, categorized as "Fair"; and SEO 78.66 and 79.33, also categorized as "Fair." Based on the Quality of Experience measurements conducted for 5 days at UNRI in both the

Faculty of Engineering Lobby and the UNRI Library using Google Lighthouse Tools, these are the results obtained:

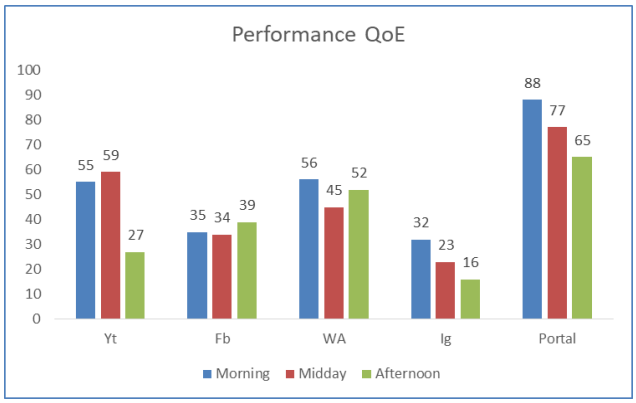

Fig. 2. Graph Of Qoe Performance Parameters in The Faculty of Engineering

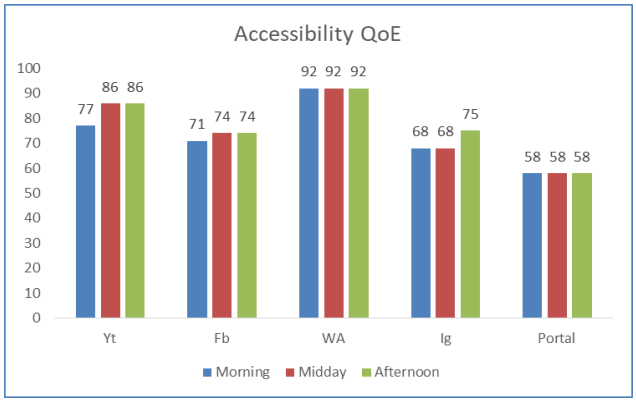

Fig. 3. Graph Of Qoe Accessibility Parameters in The Faculty of Engineering

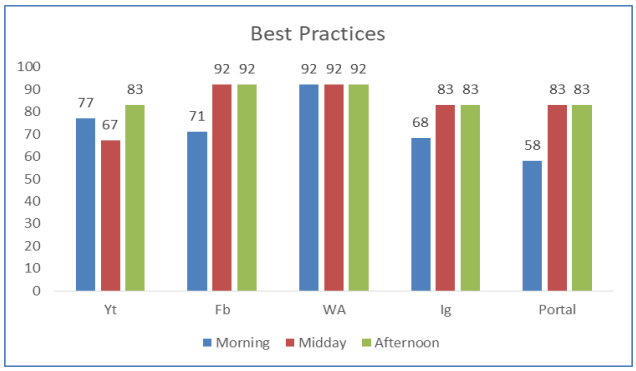

Fig. 4. Graph Of Qoe Best Practices Parameters in The Faculty of Engineering

The results of QoE measurements conducted in the morning, afternoon, and evening over the course of five days in the open network access lobby of the engineering faculty reveal that the Best Practices parameter consistently scored the highest, with an average of 85, falling into the "Fair" category. On the other hand, the Performance parameter scored the lowest, with an average of 46.86, categorizing it as "Bad." When looking specifically at the Performance parameter, the highest score was achieved by the Web Portal, reaching 88 in the morning, while the lowest score was recorded for the Instagram Web application at 16 in the afternoon. For the Accessibility parameter, the highest score across all time frames was attained by the WhatsApp Web application at 92, with the lowest score registered by the Web Portal at 58. In the case of the Best Practices parameter, the highest scores were consistently obtained by the Facebook and WhatsApp Web applications at 92, with other applications falling into the "quite good" category. Regarding the SEO parameter, the highest score was achieved by the YouTube Web application, scoring 93 in both the morning and afternoon, while other applications scored in the "fairly good" category. Looking at individual applications, the highest average score was achieved by the WhatsApp Web application, totaling 81.5, placing it in the "Fair" category, while the Web Portal had the lowest average score, 64, but it still fell within the "Fair" category.

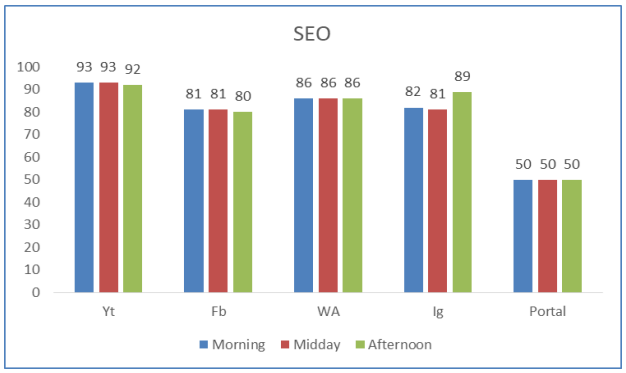

Fig. 5. Graph of Seo Parameters in The Faculty of Engineering

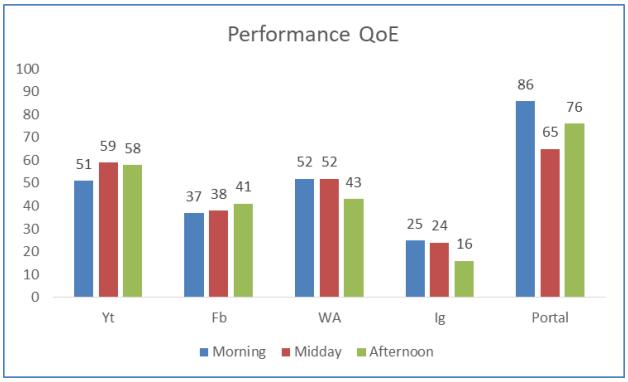

Fig. 6. Qoe Performance Parameter Graph in The UNRI Library

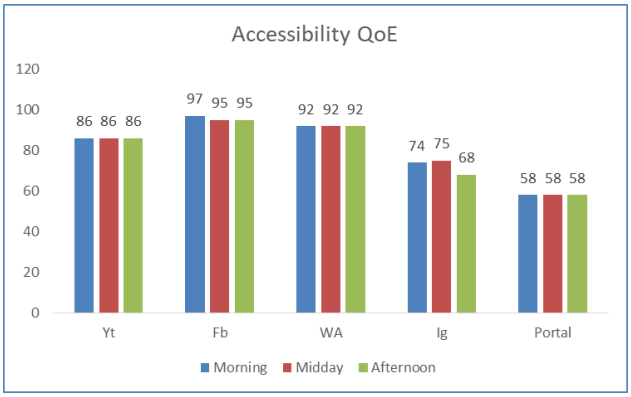

Fig. 7. Qoe Accessibility Parameter Graph in The UNRI Library

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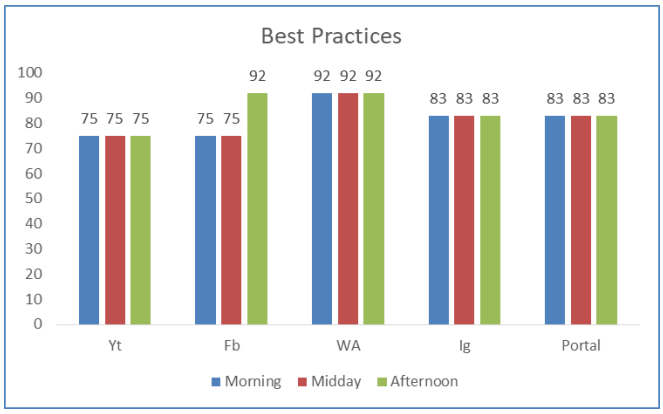

Fig. 8. Qoe Best Practices Parameter Graph in The Unri Library

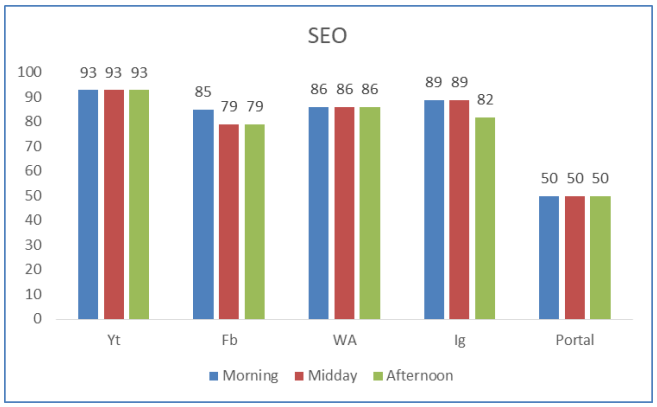

Fig. 9. Qoe Seo Parameter Graph in The UNRI Library

The results of QoE measurements in the morning, afternoon, and evening at the Riau University Library lobby of the engineering faculty indicate that the Best Practices parameter achieved the highest average score, specifically 82.7, categorizing it as "Fair." Conversely, the Performance parameter recorded the lowest score, which is 48.2, placing it in the "Bad" category. For the Performance parameter, the Web Portal scored the highest at 86 in the morning, while the Instagram Web application scored the lowest at 16 in the afternoon. Additionally, regarding the accessibility parameter, the Facebook Web application received the highest score at 97 in the morning, while other applications fell into the "fair" category. In the case of the Best Practices parameter, the WhatsApp Web application consistently scored the highest at 92, with Facebook Web also achieving 92 in the afternoon, while other application scores were categorized as "fairly good." Lastly, for the SEO parameter, the YouTube Web application achieved the highest score at 93 throughout, and other applications received scores in the "fairly good" category. When looking at individual applications, the highest average score was attained by the WhatsApp Web application, reaching 80.5 and categorized as "Fair," while the lowest average score was recorded by the Instagram Web application, with 62.25 in the afternoon, but it still fell within the "Fair" category.

IV. Conclusion

QoE network analysis was conducted using both subjective and objective methods. The subjective method involved the distribution of questionnaires via Google Forms to Riau University students who used open network access. Simultaneously, the objective method utilized open network access in the Engineering Faculty Lobby and the Riau University Library, employing Google LightHouse tools. This measurement was executed in the morning, afternoon, and evening over a span of 5 days, examining 5 web-based applications: YouTube, Facebook, WhatsApp, Instagram, and the Riau University Portal. In the subjective method, the open access network in the Faculty of Engineering Lobby and the UNRI Library exhibited an average score of 3.45, placing the University of Riau's open access network within the "fairly good" MOS category. Conversely, for the objective QoE method, the highest average score within the Faculty of Engineering was achieved by the WhatsApp Web application, registering at 81.5 and categorized as "Fair." The lowest score was recorded by the Web Portal, scoring 64, but it still fell within the "Fair" category. In the Riau University Library, the WhatsApp Web application attained the best score at 80.5, categorized as "Fair," while the worst was observed with the Instagram Web application, scoring 62.25 in the afternoon, though it too remained within the "Fair" category.

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