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Electronic Health Records (EHR) Usability and User Experience Evaluation: A Case Study

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Abstract— Manual medical record documents have a high risk of leakage and loss. This is because the storage is only in the cupboard. In Indonesia, Electronic Health Records (EHR) have been widely adopted. Clinics, the Rumah Keluarga Sehat Clinic located in Jember Regency. The implemented EHR is a complement to the manual medical record. To obtain a successful EHR implementation, it is necessary to evaluate the usability and user experience. Usability testing is an evaluation method that involves end users in the system development process. This study aims to evaluate the usability and user experience of the EHR developed at the Rumah Keluarga Sehat Clinic. Tests were carried out using the System Usability Scale (SUS) and User Experience Questionnaire (UEQ) instruments. Instruments were given to 7 respondents consisting of doctors, medical recorders, admins, and pharmacists at Rumah Keluarga Sehat Clinic, Jember. The results of the usability evaluation with SUS showed a score of 77.14 which indicated the Good category. And the UEQ results show above-average results on a scale (perspicuity and dependability), and excellent on 4 scales (attractiveness, efficiency, stimulation, and novelty). The results of the evaluation with 2 instruments show that the developed EHR has met the user's needs.

Keywords— Electronic Health Records; System Usability Scale; User Experience; Usability Testing

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I. INTRODUCTION

Medical record documentation is currently being developed electronically. The development of electronic medical records, known as Electronic Health Records (EHR), is one of the efforts made to secure patient data. Manual medical record documents have a high risk of leakage and loss. This is because the storage is only in the cupboard. In contrast to manual medical records, electronic medical record storage uses a computer device and an internet connection so that data can be stored on a server. Data storage on the server can save space and minimize data loss [1]. In Indonesia, EHR has been widely adopted. Clinics, hospitals, and other health facilities have implemented EHR. As in the Rumah Sehat Keluarga Clinic located in Jember Regency. The implemented EHR is a complement to the manual medical record.

When implementing an EHR system, healthcare facilities strive to achieve goals such as improving patient safety and physician efficiency, obtaining information for better decision-making, and increasing the accuracy and reliability of medical data [2]. However, in practice, health care facilities often fail in implementing EHR. One of the contributing factors is the lack of adoption by users [3], [4].

To obtain a successful EHR implementation, it is necessary to evaluate the usability and user experience. Usability testing is an evaluation method that involves end users in the system development process [5]. Usability measures the extent to which users use the product to achieve effectiveness and efficiency as well as satisfaction [6], [7] System Usability Testing (SUS) is one of the most widely used methods to evaluate system usability. SUS is a questionnaire with a simple 5-point Likert scale that provides an overview of the subjective assessment of the usefulness of the developed system [8]. User experience testing also needs to be done to see the success of an interactive system. User evaluation with the User Experience Questionnaire (UEQ) is one of the practical and consistent testing methods. The test questionnaire consists of 6 test scales and 26 question items for each scale [9], [10].

Implementing the EHR system becomes complex, and user experience becomes an important role that can determine the success factor. Users become actors who control the continuity of the EHR [7], [11]. The UEQ instrument has been widely used to measure user experience (User Experience) on EHR systems and computer applications developed to improve patient health services. The prediction system of patients with glaucoma and diabetes was evaluated using the UEQ instrument. The respondents used in this study amounted to 33 with different domains (age, gender, and nationality). Based on the UEQ benchmark data, the application shows relatively good results in all aspects of the assessment [12]. The evaluation of the Halodoc mobile health application conducted by [13] uses UEQ to assess user experience. The evaluation was conducted

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on 96 respondents with 32 respondents being male and 64 respondents being female. The results show that the Halodoc application with good results from all aspects of the assessment.

The Usability Scale (SUS) system was used to develop the EHR system implemented in Sweden [14]. This study collected data by survey with a total of 2587 respondents. The results showed a SUS score of 79.81. The resulting score indicates that the usefulness of the EHR is in a Good category. The target of the test is the patient. The use of SUS was used to assess the usability of the EHR system in the United States. The study was conducted in 2017-2018 with doctor respondents from various fields. From the evaluation results, obtained a SUS score of 45.9. This score falls into the "unacceptable" category. The low scores were then analyzed by the researcher and correlated with psychological causative factors [15].

Based on previous studies, the commonly used usability and user experience evaluation methods are the System Usability Scale and the User Experience Questionnaire (UEQ). These two methods are used to evaluate the usability and user experience of the EHR developed at Rumah Sehat Keluarga Clinic. The two instruments were chosen because they have good and consistent validation results [16], [17].

Based on the background described, this study tested the EHR system developed at the Rumah Sehat Keluarga Clinic. The tests carried out are usage testing and user experience testing after using the EHR system. This paper consists of I. Introduction, II. Research Methodology, III. Results, and IV. Conclusion.

II. RESEARCH METHOD

A. Research Flow

This study discusses the evaluation of EHR Rumah Sehat Keluarga Clinic that has developed and applied to clinics. Evaluation of use using the SUS and UEQ questionnaires. These two instruments measure the usability and user experience when using the developed HER Rumah Sehat Keluarga Clinic. The research flowchart is shown in Figure 1.

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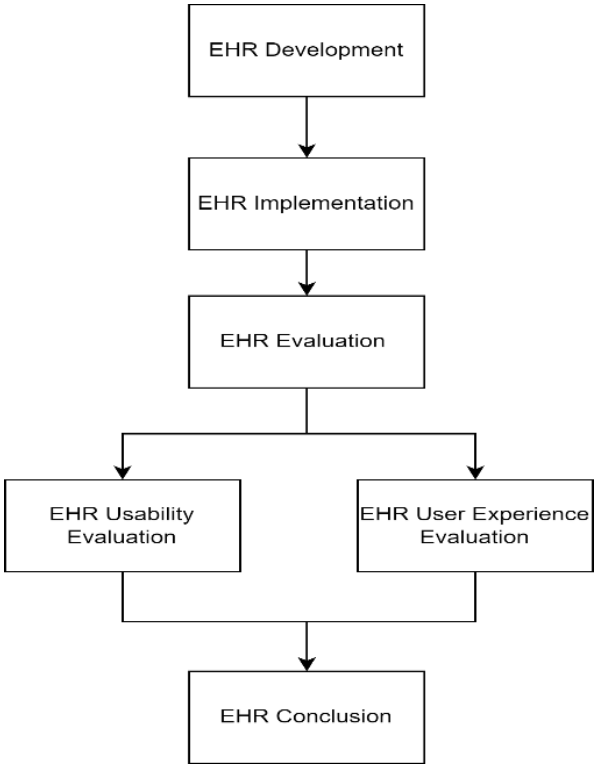

Fig 1. Research Flow Diagram

Figure 1 shows the research flow diagram. This research started with developed the EHR system and implemented at Rumah Sehat Keluarga Clinic. After the implementation phase, the EHR system will be evaluated. The evaluation phase includes usability evaluation and user experience evaluation. The results of the evaluation of the EHR system are used to determine the advantages and disadvantages of the system after the system is used by the user and as material for improvement.

B. System Usability Scale (SUS)

The SUS system (Usability Scale) is a usability evaluation method developed in [8]. This method has consistent results and does not change when the analysis is carried out. This method has the same results and does not change as the analysis is performed. This method is very useful to assess the value of the usability product [17]. SUS includes usability assessment namely effectiveness, efficiency, and user satisfaction [18], [19]. The SUS instrument consists of 10 questions using a Likert scale from 1 to 5. The SUS score is calculated by subtracting 1 from the score for questions 1, 3, 5, 7 and 9. The score for questions 2, 4, 6, 8 and 10 is 5 context. Remove the measurement from the object. The scores for each item were added and divided by 2.5. The scores for each question are averaged to obtain the SUS score.

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The formula for calculating the SUS score is:

$$\bar{x} = \frac{\sum x}{n} \quad (1)$$

Annotation:

$\bar{x}$: Average SUS score

$\sum x$: Total of SUS score

n : Number of respondents

The SUS score obtained is then interpreted as follows.

Tabel 1. SUS Interpretation [19]

SUS Score	Grade	Adjective Rating
>80,3	A	Excellent
68 - 80,3	B	*Good*
68	C	Okay
51 - 68	D	Poor
<51	F	Awful

C. User Experience Questionnaire (UEQ)

UEQ is a user experience testing instrument developed by [9] to assess whether the developed system is in accordance with user expectations. UEQ scores are displayed in graphical form which interprets 6 rating scales. UEQ assesses how user experience compares to other systems based on 6 measurement scales [20]. The instrument was developed with 6 scales, namely attractiveness, sharpness, efficiency, dependence, stimulation, and novelty. Of these 6 rating scales, there are 26 question items that function to measure each variable. The question items on the UEQ are shown in Fig. 1.

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Fig 2. UEQ Items [6]

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D. Data and Test Scenario

Respondents in this study are 7 people consisting of general practitioners, dentists, the IT team, administration, finance, medical records team, and pharmacists at Rumah Sehat Keluarga Clinic. The test was carried out after all respondents used the developed EHR system, then the research team conducted a brief training on how to use the system. Respondents will be asked to fill out the UEQ and SUS questionnaires based on their experience after using the EHR system. The questionnaire was distributed online using Google Forms. The data obtained is quantitative data and each instrument uses a Likert scale.

III. RESULT AND DISCUSSION

This research examine the usability and user experience of EHR that has implemented in Rumah Sehat Keluarga Clinic. EHR developed in this research has 4 main features. The first feature is management information of patients, financial management and report, EHR encrypted data using the 3DES algorithm, and data management of pharmacy. These 4 features are tested using System Usability Scale (SUS) and User Experience Questionnaire (UEQ) to evaluate the user experience and usability of the system that has been developed. Usability and the UX concept are closely related, however, there are differences between the two, especially in the hedonic category. The hedonist studies how enjoyable the user is in using the software. besides that, UX also assesses emotions, beliefs, preferences and perceptions [6], [21].

A. System Usability Scale (SUS)

Tabel 2. SUS Result

Respondents	**Question Items**										**SUS Score**
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	
R1	3	3	5	1	5	1	5	1	5	5	80
R2	5	1	5	3	5	1	5	1	5	5	85
R3	5	5	5	4	5	1	4	1	5	4	72,5
R4	4	2	4	5	5	2	4	2	4	4	65
R5	5	1	5	1	5	1	5	1	1	5	80
R6	5	3	5	3	4	1	1	3	4	3	65
R7	5	1	5	3	5	1	5	1	5	2	92,5
Total SUS Score											77,14

Ease of use is the degree to which an item can be utilized by certain clients to attain certain objectives with adequacy, proficiency, and fulfillment in certain utilized contexts [1]. The SUS score encompasses a run of 0-100, with an esteem of 100 being the most noteworthy esteem

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showing great ease of use [19]. The survey is outlined to be replied to after the user interatomic with the system [22]. The address things in SUS have negative and positive questions on the other hand, so that the score calculation for each odd and indeed number is distinctive. To calculate the SUS score, the commitment of each item's score (run from 1-5) must be calculated. For items 1, 3, 5, 7, and 9 the score contribution is the scale position minus 1. For items 2, 4, 6, 8, and 10 the contribution is 5 minus the scale position. The score commitments for each thing are at that point summed and increased by 2.5 to reach final score. Concurring to the assessment conducted by [17] of SUS, the system must score over 70 to be considered at the slightest passable. Way better frameworks will score tall within the tall 70s to 80s, and scores over 90 demonstrate a genuinely prevalent framework. Better systems will score high in the high 70s to 80s, and scores above 90 indicate a truly superior system [22].

Table II shows the results of the SUS score with 9 respondents. Based on the calculation results, the overall SUS score was 77.14. The scores obtained were then interpreted according to Table I. The SUS scores obtained in this study were in the Good category, with a range of values from 68 to 80.3. Thus the EHR system developed is acceptable but still needs continuous improvement and evaluation to get a system with a superior category.

Although the results of this SUS cannot determine which factors or features are problematic in the EHR system, SUS can assist in determining whether the system can be used properly according to user needs.

B. User Experience Questionnaire (UEQ)

User Experience is not alluded to as working inside as an item or service, user encounter isn't as it was connected to versatile applications, but can too be connected to measure the quality of web administrations employing a client involvement survey [16]. User experience alludes to working out, associated with the comes about of UEQ being able to comprehensively evaluate user experience [21], [23]. Using the UEQ to assess data frameworks could be a fast and compelling way. Since, the UEQ instrument centers on surveying a wide client involvement that's able to urge a quick reaction from the client. The coordinate reaction from the client gotten through UEQ can decipher the impressions, sentiments and impressions that emerge from utilizing the item [24], [25].

The results of the UEQ analysis are presented in Figure 3 form showing ratings with 6 scales. By default, the UEQ does not generate one score for each participant but instead provides six scores, one for each attribute. The UEQ results of this study are shown in Fig. 3 and Table III.

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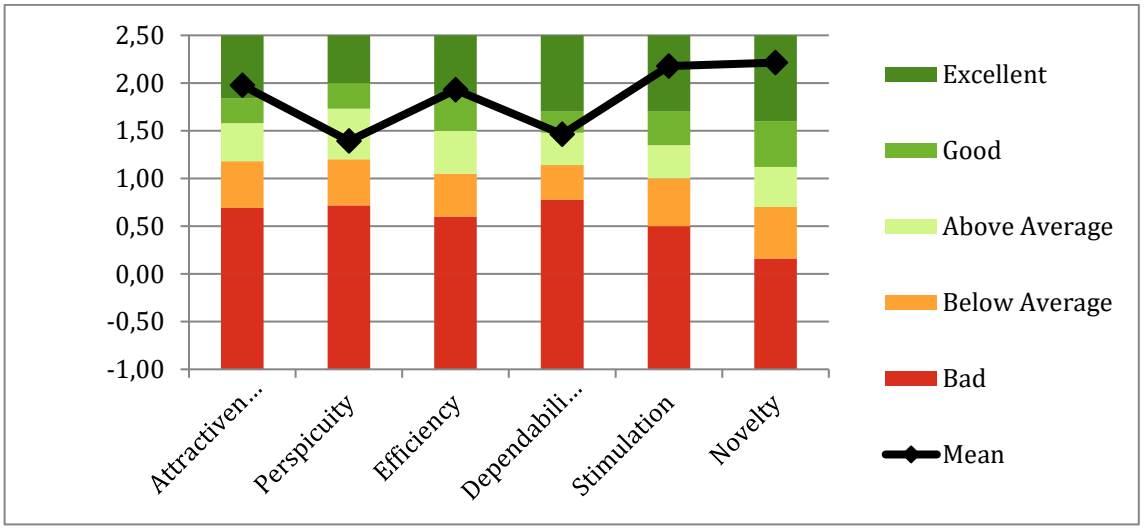

Fig 3. UEQ Benchmark Diagram

Fig. 3 is a graph of the results of respondents' assessment of the EHR system with the UEQ instrument, and Table III is the result of the mean score obtained. Based on Table III, the mean score on each UEQ rating scale shows a score > 0.8 which indicates that respondents (users) of the EHR system are satisfied in using the EHR system. The UEQ results show that on the scale of attractiveness, efficiency, stimulation, and novelty, the benchmark is excellent. Benchmark excellent has an interpretation of the assessment that almost gets the best results. On the perspicuity and dependability scales, the benchmark results are above average. The UX dimension that needs to be improved is perspicuity, because this dimension has the lowest score. Perspicuity is a very important dimension for assessing how good the user experience is with a software [26], [27].

Table 3. UEQ Score and Result Interpretation based on Benchmark

Scale	Mean	Comparisson to benchmark	Interpretation
Attractiveness	1,98	Excellent	In the range of the 10% best results
Perspicuity	1,39	Above Average	25% of results better, 50% of results worse
Efficiency	1,93	Excellent	In the range of the 10% best results
Dependability	1,46	Above Average	25% of results better, 50% of results worse
Stimulation	2,18	Excellent	In the range of the 10% best results
Novelty	2,21	Excellent	In the range of the 10% best results

IV. CONCLUSION

This research assessed and user experience of Electronic Health Records (EHR) which was developed at Rumah Sehat Keluarga Clinic. The purpose of this study was to determine the usability and user experience of the EHR system that has been implemented at the Rumah Sehat Keluarga Clinic. The evaluation process is carried out by giving SUS and UEQ questionnaires to

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users (general practitioners, dentists, medical recorders, admins, IT teams, and cashiers). The results of the usability evaluation with SUS obtained the SUS score of 77.14 which has a Good interpretation. The UEQ results show an assessment with 6 scales of achieving good results, with 2 rating scales (perspicuity and dependence) showing results above average, and 4 other scales (attractiveness, efficiency, stimulation, and novelty) getting excellent results. Good results, it shows that the developed EHR has met the needs of users, but it is necessary to carry out further testing on patients in future works and compare them with similar systems.

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