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DESIGN AND EVALUATION OF STROKE PREVENTION BASED ANDROID SYSTEM USING USER EXPERIENCE QUESTIONNAIRE (UEQ) FOR ELDERLY CAREGIVERS AT NURSING HOME

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Abstract- Elderly stroke survivors are highly prevalent in three nursing homes in West Sumatra Province, Indonesia, compared to the national prevalence. The stroke prevention application has been developed on an Android smartphone to provide stroke prevention services. This study aimed to assess the evaluation results of caregivers using the User Experience Questionnaire (UEQ). The research was a quantitative study conducted among caregivers of elderly in nursing homes in West Sumatra Province, Indonesia, from October 2021 to January 2022. The analysis utilized the User Experience Questionnaire (UEQ), which has been verified for validity and reliability. The results of the evaluation of the stroke prevention applications by caregivers were positive in all six scales and all three aspects (scale groups). The application quality was rated excellent in terms of novelty, good in terms of efficiency, dependability, and stimulation, and above average in terms of attractiveness and clarity. This indicates that elderly caregivers in nursing homes in West Sumatra Province, Indonesia, have a favorable view of the stroke prevention applications.

Keywords: Stroke, Prevention, Android Application, User Experience Questionnaire (UEQ), Elderly-Caregiver.

1. INTRODUCTION

Now, digital healthcare plays an important role in healthcare. The benefits of digital health are reflected in the interoperable data, the integration of artificial intelligence, and the secure platform that focuses on providing patient-centered and preventive care [1]. Digital health involves not just technology but also the use of information and communication technology to prevent diseases and enhance the quality of life. Mobile health (M-health) is mobile applications and technologies, a rapidly growing suite, primarily to help manage long-term chronic conditions, as they can provide access to health care support and monitoring [2], [3]. The Digital Health and Innovation department of WHO is committed to seeking out, investigating, and promoting the best health-related digital technologies and other innovations to help all people attain the highest level of health possible, as part of the achievement of the WHO's Thirteenth General Program of Work (GPW13) Triple-Billion-Goals and Sustainable Development Goal 3 (SDG3) [4].

Every year, there are 14.5 million people who have a stroke, 5.5 million people die, and 80 million people suffer from post-stroke disabilities. One in every four people will have a stroke in their lifetime [5]. In Indonesia, stroke is the third-leading non-communicable disease among the elderly. Many elderly stroke survivors reside in nursing homes. An initial survey conducted in 2020 at three nursing homes in West Sumatra Province discovered a significant stroke prevalence rate among the elderly in these homes. The prevalence was 9.1% at PSTW Sabai-Nan-Aluih, 8.5% at PSTW Kasih-Sayang-Ibu, and 16% at PSTW Jasa-Ibu, which is higher than the national stroke prevalence rate of 4.4%. It is very important to prevent stroke, especially in people who are at high risk [6], [7].

One of the comprehensive stroke prevention strategies, according to Feigin, et al., is to use technology and information to advance approaches to prevention and techniques [8]. The stroke prevention application (ERDANELA model) has been developed for an Android smartphone in collaboration with IT experts. The aim of this study was to determine the results of caregiver evaluation (User Experience) on the ERDANELA Stroke Prevention Application based on Android, using the UEQ questionnaire to assess six scales: a) attractiveness, b) perspicuity, c) efficiency, d) dependability,

e) stimulation, and f) novelty, and to assess three aspects: 1) Attractiveness, 2) Pragmatic Quality, 3) Hedonic Quality, as well as assessing the quality (relative) of the application (benchmark) measured by other products. The purpose of this application is to help caregivers reduce the incidence of strokes among elderly residents in nursing homes. It achieves this by assessing the risk of stroke among the elderly, providing education and information, and promoting early detection of strokes.

2. MATERIALS AND METHODS

The stroke prevention application has been developed for an Android smartphone using Android Studio software in collaboration with IT experts to support this research [9]. The application utilizes the National Stroke Association's Stroke Risk Scorecard as the input tool to assess the level of stroke risk in the elderly [10]. The input from the stroke risk scorecard is then processed through an algorithm to produce an output that categorizes the elderly's stroke risk level into three categories: high risk, caution, and low risk. Then, input recommendations for risk factor management education, the fast method of early detection of stroke, the ambulance phone feature, and the history of elderly test results. An Android-based display is designed, and the keyword for this application that has been registered on the Google Play Store is Erdanela Cegah Stroke (ECS), with a user interface in Figure 1.

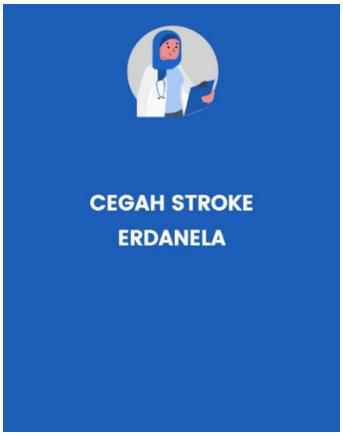

Figure 1. User interface of ECS

The aim of this study was to determine the results of caregiver evaluation (User Experience) on ECS based on Android using the UEQ questionnaire to assess six scales: a) attractiveness, b) perspicuity, c) efficiency, d) dependability, e) stimulation, f) novelty, and to assess three aspects: 1) attractiveness, 2) pragmatic quality, and 3) hedonic quality, as well as the quality (relative) of the application (benchmark) measured by other products. This application helps caregivers in nursing homes reduce the incidence of strokes among the elderly by determining the stroke risk level of each elderly individual, educating them, and detecting strokes early. According to [11] measuring user experience research frameworks such as the Questionnaire for User Interaction Satisfaction (QUIS), the Standardized User Experience Percentile Rank Questionnaire (SUPR-Q), the System Usability Scale (SUS), and the Software Usability Measurement Inventory (SUMI).

All of the frameworks used in user experience research to identify perception and response to any product, system, or service, including users' emotional performance, beliefs, preferences, cognition, physical and psychological reactions, behavior, and achievements [12]. In this study, we conducted the User Experience Questionnaire (UEQ), since this method is fast and reliable when measuring user experiences. The scales of the questionnaire deal with aspects of usability (efficiency, perspicuity, dependability), and user experience aspects (originality, stimulation) are measured [13]. The study participants were elderly caregivers and staff from three nursing homes in the West Sumatra province, making up a total of 52 elderly individuals. The characteristics of the 52 elderly caregivers in these nursing homes in West Sumatra Province, Indonesia are described as follows:

Table 1. Characteristics of elderly caregivers (n=52)

Characteristics	f	%	Mean ± Std. Dev Min-Max
1) Age:			
<40 years old	15	28.8	46 ±
40-49 years old	18	34.6	11
50-59 years old	14	26.9	24-71
>60 years old	5	9.7	
2) Gender:			
Man	27	51.9	-
Woman	25	48.1	
3) Education:			
Primary school	5	9.6	
Middle school	25	48.1	-
High school or higher	22	42.3	
4) Have an Android Phone:			
Yes	52	100.0	-
Not	0	0.0	
5) Can operate smartphones well: (Downloading and installing)			
Can	42	100.0	-
Not	0	0.0	
Total	52	100,0	

The total sampling method was used to determine the number of samples, based on the following exclusion criteria: a) Caregivers who are unable to read and write, b) Caregivers who do not have an Android smartphone, c) Caregivers who are medical personnel, and d) Caregivers who are unwilling to attend training. The final number of samples was obtained through this process. In Table 1 shows the majority of caregivers are middle-aged or 40-49 years old with an average age of 46 years old, while the oldest caregivers are 71 years old and the youngest 24 years old. The majority of caregivers are male (51.9%), have middle school education 48.1%. All caregivers (100%) have an android phone and can operate it well (can download and install). The uses of UEQ are: 1) to compare the level between two products, 2) to check the User Experience of a product, 3) to determine areas for improvement of a product, and 4) to see the relative quality of using applications in Android smartphones compared to other products (benchmarks) fast and reliable [14].

Table 2. User Experience Questionnaire (UEQ) item

No	Evaluation									Quality Scale
	Negative	1	2	3	4	5	6	7	Positive	
1	Annoying	O	O	O	O	O	O	O	enjoyable	Attractiveness
2	Not Understandable	O	O	O	O	O	O	O	understandable	Perspicuity
3	creative	O	O	O	O	O	O	O	dull	Novelty
4	easy to learn	O	O	O	O	O	O	O	difficult to learn	Perspicuity
5	valuable	O	O	O	O	O	O	O	inferior	Stimulation
6	boring	O	O	O	O	O	O	O	exciting	Stimulation
7	not interested	O	O	O	O	O	O	O	interesting	Stimulation
8	unpredictable	O	O	O	O	O	O	O	predictable	Dependability
9	fast	O	O	O	O	O	O	O	slow	Efficiency
10	inventive	O	O	O	O	O	O	O	conventional	Novelty
11	obstructive	O	O	O	O	O	O	O	supportive	Dependability
12	good	O	O	O	O	O	O	O	bad	Attractiveness
13	complicated	O	O	O	O	O	O	O	easy	Perspicuity
14	unlikable	O	O	O	O	O	O	O	pleasing	Attractiveness
15	usual	O	O	O	O	O	O	O	leading edge	Novelty Scale
16	unpleasant	O	O	O	O	O	O	O	pleasant	Attractiveness
17	secure	O	O	O	O	O	O	O	not secure	Dependability
18	motivating	O	O	O	O	O	O	O	demotivating	Stimulation
19	meet expectations	O	O	O	O	O	O	O	does not meet expectations	Dependability
20	inefficient	O	O	O	O	O	O	O	efficient	Efficiency
21	clear	O	O	O	O	O	O	O	confusing	Perspicuity
22	impractical	O	O	O	O	O	O	O	practical	Efficiency
23	organized	O	O	O	O	O	O	O	cluttered	Efficiency
24	attractive	O	O	O	O	O	O	O	unattractive	Attractiveness
25	friendly	O	O	O	O	O	O	O	unfriendly	Attractiveness
26	conservative	O	O	O	O	O	O	O	innovative	Novelty

To start the data analysis process, the data has been collected into the excel worksheet and required statistical analysis then interpret the results of the questionnaire. In order to interpret the results accurately and easily, the data is processed using UEQ Data Analysis Tool version 10 which can be downloaded on the page ueq-online.org [13]. The analysis was carried out using the average value (mean) for each indicator. The mean value of each scale is then interpreted into positive, neutral and negative evaluations. Interpretation of the mean value of each aspect/scale: if mean > 0.8 is Positive Evaluation, if mean -0.8 – 0.8 is Neutral Evaluation, and if mean < -0.8 is Negative Evaluation [15]. Mean value of 6 UEQ scales: a) Attractiveness scale. Caregiver's impression of the whole application. Does the caregiver like the app or not, b) Perspicuity scale The UEQ tool is available free of charge to use at no cost [11] and the UEQ contains 6 scales with 26 items as shown in Table 2.

Ease of caregivers to get to know the application and learn how to use it, c) Efficiency scale. Caregivers can complete tasks without trying hard and the app reacts quickly, d) Dependability scale. Caregiver can control the application, the application is predictable and safe to use, e) Stimulation scale. The application is interesting and motivating and fun to use, f) Novelty scale. The application design was creative or attractive can make interest for caregivers. The mean value of the group scale which consists of 3 aspects: a) The attractiveness aspect is the main part of the UEQ as a pure dimension related to caregiver's perception of the application on attractiveness. b) The pragmatic quality aspect shows caregiver's perception to aspects of technical that are focused on achieving purposes (determining level of stroke risk) in application design efficiently and quickly (dimension of efficiency), understandable (dimension of perspicuity), and not restraint (dimension of dependability). c) Hedonic quality aspect relates to non-technical aspects related to caregiver feelings involving pleasure and motivation (dimension of stimulation) and innovative design (dimension of novelty) [16]. The Quality (Relative) of ECS in android smartphones compared to other products in all evaluations using data of contains data from 21175 persons from 468 studies. Every year the benchmark is updated. Classification of the benchmark: 1) Excellent quality, 2) Good quality, 3) Above average quality, 4) Below average quality, 5) Bad quality.

3. RESULT AND DISCUSSION

In this section will be explain the details of this study result based on Mean Value of 6 UEQ Scales and Mean Value of 3 Group Scales or 3 Aspects of UEQ. Mean Value and Interpretation of 26 Item of 6 UEQ Scales and Conclusions are presented in Table. Almost all items on the Attractiveness scale get positive evaluations, except for items 2 and 5 get neutral evaluations. The total mean = 1.48 of Attractiveness scale get Positive Evaluation therefore, ECS in Android Smartphones are enjoyable, not bad but also not good, pleasing, pleasant, not attractive but also not unattractive, and friendly. The Perspicuity scale get a positive evaluation, except for item 4 which gets neutral evaluations.

The total mean = 1.48 of Perspicuity scale get Positive Evaluation, it means that ECS in Android Smartphones are understandable, easy to learn, easy or not complicated, and not clear but also not confusing. It is not all items on the Efficiency scale get positive evaluation which Items 1 and 4 get neutral evaluations.

Table 3. Mean value and interpretation of 26 items of 6 UEQ scales and conclusions (a: Positive evaluation; b: Neutral evaluation)

SCALE	No	ITEM		Mean	Interpretation	Conclusion
1. Attractiveness	1	annoying	enjoyable	2.8	a	Mean 1.48 Positive Evaluation
	2	good	bad	0.8	b	
	3	unlikable	pleasing	1.4	a	
	4	unpleasant	pleasant	2.6	a	
	5	attractive	unattractive	0.4	b	
	6	friendly	unfriendly	1.0	a	
2. Perspicuity	7	not understandable	understandable	2.7	a	Mean 1.48 Positive Evaluation
	8	easy to learn	difficult to learn	1.1	a	
	9	complicated	easy	2.6	a	
	10	clear	confusing	-0.5	b	
3. Efficiency	11	fast	slow	0.8	b	Mean 1.62 Positive Evaluation
	12	inefficient	efficient	2.8	a	
	13	impractical	practical	2.7	a	
	14	organized	cluttered	0.2	b	
4. Dependability	15	unpredictable	predictable	2.4	a	Mean 1.52 Positive Evaluation
	16	obstructive	supportive	2.7	a	
	17	secure	not secure	1.0	a	
	18	meets expectations	does not meet expectations	-0.0	b	
5. Stimulation	19	valuable	inferior	1.1	a	Mean 1.44 Positive Evaluation
	20	boring	exciting	2.5	a	
	21	not interesting	interesting	2.6	a	
	22	motivating	demotivating	-0.4	B	
6. Novelty	23	creative	dull	0.8	B	Mean 1.63 Positive Evaluation
	24	inventive	conventional	0.6	B	
	25	usual	leading edge	2.4	a	
	26	conservative	innovative	2.7	a	

The total mean = 1.62 for Efficiency scale get positive evaluation therefore ECS in Android Smartphones are not fast but also not slow, efficient, practical and not cluttered but also not organized. Moreover, not all items on the Dependability scale ger positive evaluation. Item 4 get a neutral evaluation with the total mean = 1.52 while Dependability scale get positive evaluation in ECS are predictable, supportive, secure and does not meet expectations but also not does not meet expectations.

From the Stimulation, both all items scale gets positive evaluation which item 4 get a neutral evaluation with the total mean = 1.44. The stimulation scale gets positive evaluation, the ECS are valuable, exciting, interesting and not motivating but also not demotivating. It is not all items on the Novelty scale get positive evaluations which items 1 and 2 get a neutral evaluation with total mean = 1.63. Novelty scale get Positive Evaluation it means that the ECS are not creative but also not dull, not inventive but also not conventional, leading edge, and innovative. Figure 2 shows that the six scales (Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty) UEQ are in the scale range between +1 (good) and +2 (very good). Its means that the ECS are at between good and very good level for all scales marked with the green area that can be seen in Figure 2.

Meanwhile, for Mean Value, Dimension and Interpretation of 3 Group Scales or 3 Aspects of UEQ are shown in Table 4.

In Table 4 above show the results of assessment from each group scales exhibit the caregiver's perception of attractiveness the application gets positive evaluation, with mean value = 1.48. The caregiver's perception to aspects of technical that are focused on achieving purposes (determining level of stroke risk) in application design efficiently and quickly (dimension of efficiency), understandable (dimension of perspicuity), and not restraint (dimension of dependability) gets positive evaluations, with mean value = 1.54 The caregiver's perception of non-technical aspects related to caregiver feelings involving pleasure and motivation (stimulation dimension) and innovative design (novelty dimension) get positive evaluation, with mean value = 1.54. Figure 3 shows that the 3 Group Scales or 3 Aspects (Attractiveness, Pragmatic Quality, and Hedonic Quality) of UEQ are located in the scale range between +1 (good) and +2 (very good).

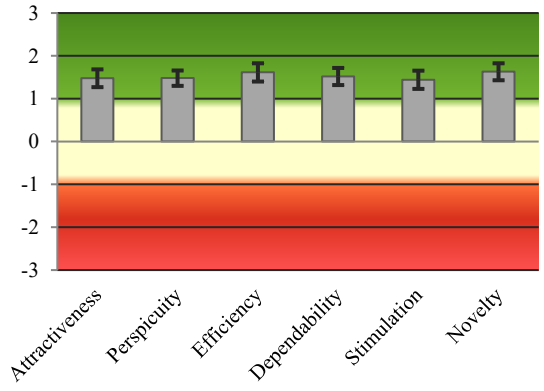

Figure 2. Graph of mean value of 6 UEQ scales

Table 4. Mean values, dimension and interpretation of 3 group scales or 3 aspects of UEQ

Group Scales	Dimension	Mean Value	Interpretation
Attractiveness	Attractiveness	1.48	positive evaluation
Pragmatic Quality	Perspicuity Efficiency Dependability	1.54	positive evaluation
Hedonic Quality	Stimulation Novelty	1.54	positive evaluation

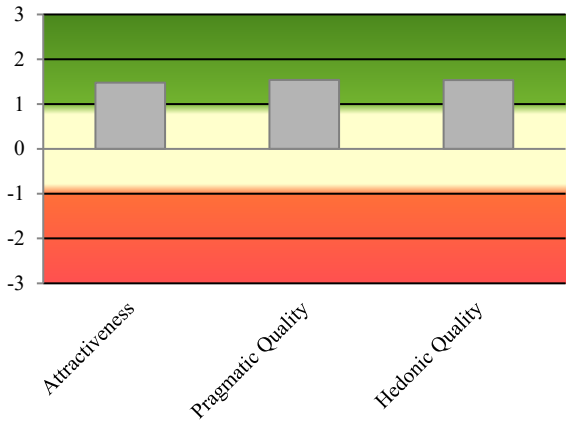

Figure 3. Graph of mean value of 3 group scales or 3 aspects of UEQ

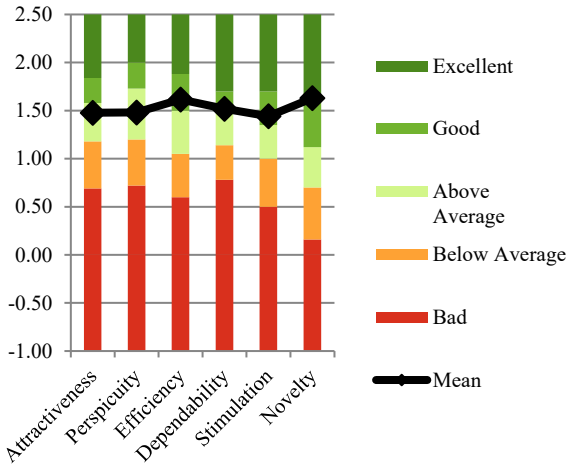

Figure 4. Graph of quality (relative) of applications (benchmark)

It means that ECS in Android Smartphones are at between good and very good level for all group scales marked with the green area. The ECS has been developed with personal IT. According to [16], the characteristics of a good interactive product (Application) have Utility and Usability. Utility is the ability of the application to provide the necessary functions for a task, namely the identification of stroke levels and the usability is the ability of application to determine the stroke rate of the elderly in general. Stimulation is the ability of the application to provide surprises to attract interest and provide opportunities to improve user knowledge and skills. Beauty is the ability of applications to create a sense of beauty. Communication identity is the ability of applications to convey symbols that are relevant to other things [16]. To evaluate the quality of the application, we compared its performance against the Expectation Confirmation Scale (ECS) across different categories, including Attractiveness (mean score of 1.48, with 25% better and 50% worse or above average results), Perspicuity (mean score of 1.48, with 25% better and 50% worse or above average results), Efficiency (mean score of 1.62, with 10% better and 75% worse or good results), Dependability (mean score of 1.52, with 10% better and 75% worse or good results), Stimulation (mean score of 1.44, with 10% better and 75% worse or good results), and Novelty (mean score of 1.63, with results in the top 10% or rated as excellent).

Quality (Relative) of ECS in Android Smartphones such as Excellent quality for Novelty, Good quality for Efficiency, Dependability and Stimulation, above average quality for Attractiveness and Perspicuity. From Figure 4, it can be seen that the Quality (Relative) of ECS in Android Smartphones are located in the scale range between +1.00 and +2.00. Meaning: Applications are at between above average and excellent level for 6 scales marked with the green area. The ECS also has pragmatic and hedonic values. According to Helen Sharp, et al, what is assessed from an application product is its pragmatic and hedonic value. The pragmatic value of the ECS for caregivers refers to its simplicity, practicality, and clarity in assessing the level of stroke risk in the elderly. The hedonic value means that caregiver interactions with the ECS are stimulating [17].

Primary stroke prevention should utilize information technology. Accumulating evidence has demonstrated the feasibility and effectiveness of using cellular technology to promote a healthy lifestyle and several medical conditions that predispose to stroke. Good use of technological advances (applications), must be widely accessible, affordable, and validated. Applications should be able to function to recognize a person's risk and risk factors, to educate about stroke warning signs that can communicate risk and the importance of addressing risk factors and motivate the person to control their risk factors, to provide targeted advice on how to reduce risk, and to measure the effectiveness of primary prevention of NCDs [8].

4. CONCLUSION

The findings of this study have important implications for the design and development of healthcare applications and highlight the importance of considering both technical and non-technical aspects of usability and user experience. Specifically, the importance of considering both technical and non-technical aspects of usability and user experience, and the need to balance utility and usability with aesthetics and motivation. Additionally, the UEQ may be a useful tool for evaluating the quality of healthcare applications, particularly those designed for elderly populations. Elderly caregivers at nursing-homes in the West Sumatra Province, Indonesia give Positive Evaluation for the ECS in android smartphone. Compared to other products, the ECS have excellent quality for novelty, have good quality for efficiency, dependability, and stimulation and have above average quality for attractiveness and perspicuity. In this study found that the ECS in Android smartphones for stroke risk assessment are enjoyable, understandable, efficient, practical, secure, valuable, interesting, and innovative, but not necessarily attractive or motivating. The study also found that the application performed well in terms of usability and utility, as well as meeting expectations for most aspects of the ECS. However, there were some areas where improvements could be made, such as increasing attractiveness and motivation. This study provides

valuable insights into the usability and user experience of an Android smartphone application for stroke risk assessment. While the application performed well overall, there were some areas where improvements could be made.

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