Development and Usability of a Mobile Application on Pressure Ulcers Among Stroke Patient

[1]Linlin Lindayani, [2]Yustiaz Iqlima Putri Ayu Suryawan
[1]Department of Nursing, STIKep PPNI Jawa Barat, Bandung
[2]Bachelor Nursing Study Program, STIKep PPNI Jawa Barat, Bandung

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Corresponding author
Linlin Lindayani*
Sekolah Tinggi Ilmu Keperawatan PPNI Jawa Barat, Bandung, Indonesia
Jl. Muhammad No 34 Bandung, Indonesia

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Abstract

Objective: The increasing global use of smartphones has contributed to the growing use of apps for various health conditions, showing promising results. Through mobile apps, it is possible to perform chronological and iconographic follow-up of wounds, such as pressure ulcers, using a simple and practical tool..

Method: The methods used in this research are descriptive, heuristic, and usability studies of an application called "SinoBed". The usability of the application is analyzed by users when the application has been disseminated and can be used. This research was conducted at STIKep PPNI Jawa Barat.

Results: The usability test consisted of 15 end users participated, with nurses who have experience working with stroke patients, possess personal cellular devices, and are proficient and acclimated to using cellular applications; 66% of them were women and 33% were men. Their mean age was 34,4 years (SD=9,07), and 80% of them were student non-regular users. Completing the questionnaire and creating an account were the next two tasks that took the longest on average to complete, after downloading and installing the application. With an average usability score of 100.3, the lowest score was 84 and the highest was 124. Usability was therefore framed at one level (80=totally agree), which indicates that the app prototype's usability is good.

Conclusion: Test findings indicate that the application prototype's development has a high degree of usability. Users expressed complete agreement with the items on the sure instrument; this suggests that the product was designed with programming that takes into account respondent's satisfaction, effectiveness, and efficiency when the application is later launched.

Keywords: Development, Usability, Mobile Application, Pressure Ulcer, Stroke

INTRODUCTION

A functional brain disorder, stroke is characterized by nerve paralysis resulting from compromised blood supply to the brain. According to the World Stroke Organization (WSO), 13.7 million new strokes occurred. Every year, and about 5.5 million people die from strokes. Stroke incident increases with age. About 60% of all strokes occur on people under age 70 and about 8% under age 44 (Feigin et al., 2022). The number of deaths from stroke was 6,552,724 and the number of persons with stroke disabilities was 143,232,184. Between 1990 and 2019, there was a 70% increase in stroke incidence, a 43% increase in mortality and a 143% increase in morbidity in low- and middle-income countries (Feigin et al., 2022). Men predominate over women. Developing among the complications of stroke patients are pressure ulcers (Lichterfeld-Kottner et al., 2020).

Pressure ulcers are defined as localized damage to the skin or underlying tissue, typically over a bony prominence, resulting from sustained pressure, which may present as intact skin or open ulcer. They are usually caused by prolonged sitting or lying in one position. Populations at high risk include

people who are frail and old and people with spinal cord injuries (Silva et al., 2022). The National Pressure Ulcer Advisory Panel (NPUAP) defines a pressure ulcers as a skin that is intact or not intact with a local area that shows a color change that does not stop, does not pale, is old red, maroon red, or purple, or separates the epidermis that indicates the bottom of a dark wound or a blister containing blood (Amirsyah et al., 2020). Pressure ulcers commonly occur when a person sleeps in bed, in a chair or spends most of their time in bed or a chair. The impact of pressure ulcers on patients includes pain, depression, local infection, osteomyelitis, anemia, sepsis, gangrene and death (Herly et al., 2021).

Scheduling a laying position while in bed is one way to avoid pressure ulcers. Changing a person's position helps reduce the likelihood of pressure ulcers. The two main variables that affect the development of pressure ulcers are the level of pressure and the duration of the pressure load (Kim & Shin, 2021). A shift in laying position or mobilization is an appropriate nursing intervention and is carried out every 2 hours on a periodic basis. This is due to the movement of the lining reducing the pressure caused by the patient's holding in a given position to reduce the pressure and friction of the skin (Herly et al., 2021).

A recent study shows, there is an app for elderly patients in bed equipped with a system they should be monitored by the Elderly Care System. This comprises a real-time monitoring system, an in-bed position prediction system, and a notification system. Pressure signals from weight sensors and vibrational signals from piezoelectric sensors are used to detect in- bed posture. A neural network and a Bayesian network are used to classify the users' position based on the wave signs

obtained from the sensors (Silva et al., 2022). In addition, a new method was found for extracting features from pressure mattress data is offered. Utilizing discriminative features like local binary patterns and histograms of oriented gradients, which are computed from the original pressure image, a basic feedforward neural network is trained to identify four different body lying postures, distinguishing between supine and probe with a classification accuracy that outperforms several other cutting-edge methods. The system was still not put to use in a real-world setting and was only tested using data from healthy subjects (Silva et al., 2022).

The development of the digital world is now widespread in various places, leading to the emergence of many internet applications for digital health services. Mobile application used to monitor health information are one of the most important health services, and information about them must be understood quickly and accurately for prevention and treatment can be done. Mobile applications for stroke rehabilitation have become an emerging area of interest because of their mobility, multi-functional capabilities such as reminders and videos, and their ability to give patients autonomy over (Szeto et al., 2023). A 2018 systematic review defined several mobile apps for stroke rehabilitation with the potential to be clinically efective (Szeto et al., 2023). When users assess an app, their interaction with the product is strengthened, often identifying needs for improvements not anticipated in the initial design (Koepp et al., 2020).

The existence of a cellular application designed to assist stroke patients with pressure ulcers in their rehabilitation is largely unknown, and there is a lack of prior research examining the usability and development of such applications as "SinoBed" for mobile devices, which specifically targets the prevention of pressure ulcers in stroke patients. It is conceivable and effective to use the "SinoBed" mobile application for rehabilitation purposes in order to reduce the risk of pressure ulcers paralysis in stroke patients. SINOBED (*Smart Innovation Bed*) is constructed upon a programming system that has been established as the primary application development component. The inspiration for the "SinoBed" mobile application came from a number of stroke patients who struggled to regulate the amount of time spent lying down in order to avert the formation of pressure ulcers.

Usability is a critical product feature and standards on usability are highly focused on evaluation procedures and specific aspects (Formicola et al., 2023). According to

International Organization for Standardization (ISO), usability is defined as “the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”. The concept of usability is extremely broad and the scientific literature includes such as: ease of use, learnability, flexibility, attitude, and memorability (Formicola et al., 2023). Furthermore, since usability is applicable to both software and hardware it encompasses a wide range of applications, including apps, websites, computer mice, smartphones and machinery (Formicola et al., 2023).

The objective of this research endeavor is to provide users with information pertaining to the ongoing development of the "SinoBed" application, which aims to assist stroke patients with pressure ulcers in their rehabilitation process by observing functional outcomes and a reduction in lesion severity. This research will specifically investigate the impact of the functionalities offered by the "SinoBed" mobile application on the outcomes of stroke rehabilitation. Maintaining awareness of the user's comfort level while utilizing the mobile application "SinoBed" is of the utmost importance and should persist throughout the healing process of the patient. As a result, it is critical for end users to ascertain whether mobile applications utilized for pressure ulcer monitoring possess notable attributes such as functionality, dependability, usability, efficiency, compatibility, security, maintenance, and portability. To ensure optimal utilization, it is advisable to extend the development period of the "SinoBed" mobile application.

METHODS

Apps Development

After conducting an analysis of prior applications that solely offered fabric- based sensors, we proceeded to calibrate them with applications that assess the pressure-induced risk of developing pressure ulcers. "SinoBed" is a smartphone and tablet software application that has undergone testing in which screening, rudimentary intervention, and integration with automatic sensors are incorporated for the benefit of stroke patients.

Android has become the most popular mobile operating system operating system to date due to the open nature of the android platform for developers todevelop their own applications. Application development stages used by researchers; 1) Research; This stage is carried out to find out what appearance and similar application systems are generally desired or are currently in trend. Trying to create new innovations that are made in such a way that our applications can be better than anyone else's already exist today. 2) Requirement analysis; This application is only made for Android version 5.0 with a Google Pixel 3 screen display developed and designed using Kodular software. This application has been automatically programmed in Indonesian, with the coding stored in the tool block. Some applications that can be categorized as client server database applications and our application as a client will beinterface with mysql server for the database. The database we use in this application is MySQL with a data transfer method inserted into Excel (Voutama & Novalia, 2021). 3) Design; In order to make it attractive, several designs are made using Canva Premium to make the appearance design and also the flow of the application. In addition, we also use Flaticon as the icon of the menu in the application. 4) Implementation; This is what we call coding. At this stage, our front-end and back-end work on each of the parts. For example, the front end uses a design made in Canva Premium with a background template from Pinterest to make it visually attractive. Then the back end develops a component or coding to ensure that the application works properly. After that, the application can be exported and run. 5) Testing; The point is to ensure that the system in the application can run smoothly and no problems will arise when it is used in the community. The testing carried out is in the form of black box testing and white box testing. 6) Deployment; Application development phase can be advanced to deployment or implementation. Once the test results have looked good, we can immediately launch this app and upload it directly to the Google Play Store. 7) Maintenance; If a problem is found in the future, we need to fix it. We'll check

which part is in trouble and then we'll see on the coding part, if there's anything missing on the block. By analyzing what's wrong, we can make our applications better than ever (Voutama & Novalia, 2021).

Content

There are eight different functions that make up the SinoBed application. 1) User identification; 2) Log In or Sign Up; 3) Home; 4) Data screening; 5) Nursing assessment; Controls positioning bed; 6) Education; 7) Help. The "SinoBed" prototype is an innovative app that makes use of the capabilities of the user's mobile device without requiring an active internet connection. In order to be compiled for Android systems, SinoBed uses User- Centered Design, HTML, CSS, and JavaScript across its 8 menus and 64 screens.

Study Design

Usability testing of the "SinoBed" mobile application and the heuristic method are utilized in this study. The severity of pressure ulcers in stroke patients can be mitigated through the use of our mobile application. The application prototype was assessed in terms of its utility by users. In stages, the efficacy of this application will be evaluate. Additionally, publicity is being conducted on the application while it undergoes trademark and software registration. The quality of the application is guaranteed by the qualification test. The research was conducted in December 2023.

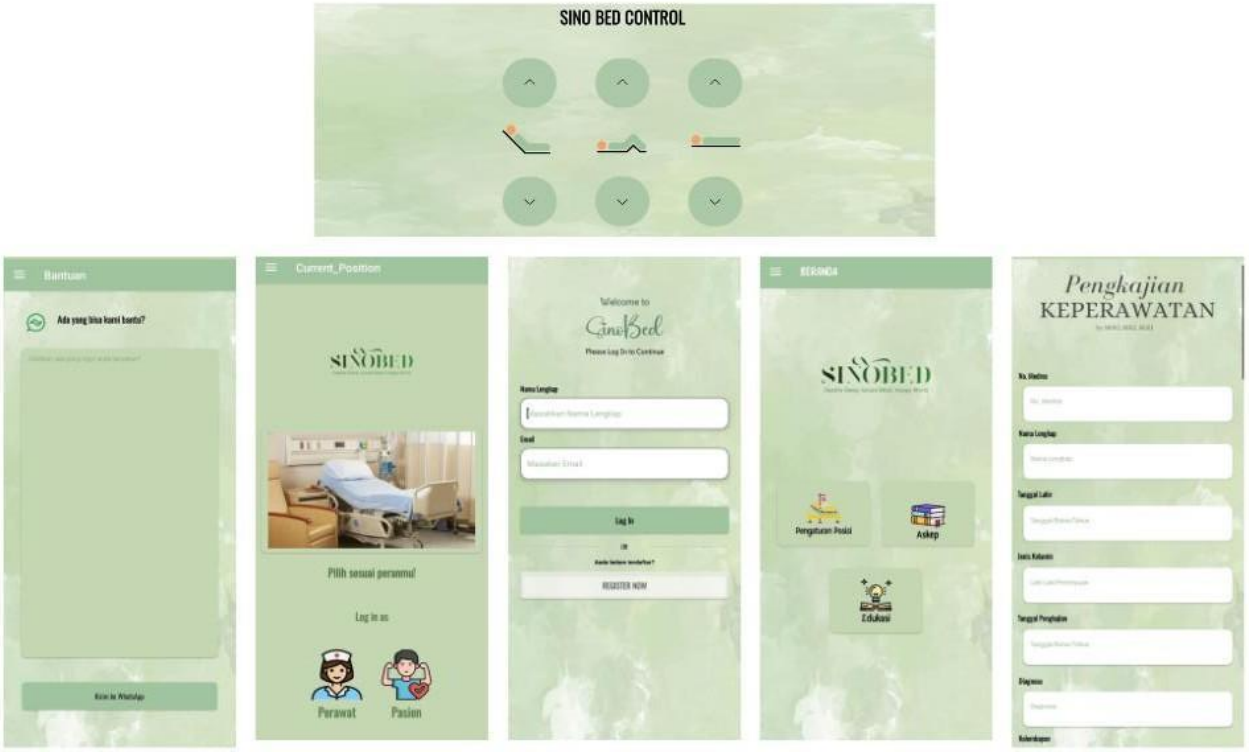

Figure 1. Mobile Application "SinoBed"

Sample

Fifteen nurses were selected to utilize this application based on the sampling results of the questionnaire obtained from SURE Instrument. Sampling qualifications have been established for nurses who have experience working with stroke patients, possess personal cellular devices, and are proficient and acclimated to using cellular applications.

Study Protocol

The hospital's on-duty nurses were contacted by the researchers. After giving the respondents an overview of the study, the researchers talked about its goals and showed them a tutorial that went over the features of the application prototype. In order for the respondents to consent to this research, they had to fill out a Google form with a Statement of Free and Informed Consent. As previously mentioned by the researcher, respondents began by downloading the prototype of the application. The researcher will take into account each feature that the respondent clicks on and compute the results. Next, using the SURE Instrument's, the respondent will complete a questionnaire. Eight tasks are necessary to fulfill the primary goal of this application, which is to summarize the IRT results.

Nurses who possess personal cellular devices, have prior experience working with stroke patients, and are well- versed and comfortable with utilizing cellular applications have been assigned sampling criteria. The app was made available for usage on the user's choice of mobile device (smartphone or tablet). The SURE (Smartphone Usability questionnaire) usability measurement instrument was administered after an average of 20 minutes of handling, or when the user felt the time was sufficient (Gresse et al., 2014). SURE is comprised of 31 items, all of which are smartphone-centric and were created using Item Response Theory (IRT). The respondent rated their level of agreement with each statement using the following criteria: 1 = Very Poor, 2 = Fair, 3 = Good, 4 = Excellent, and NA= Not Applicable. The tool's overall score was calculated by adding up all of the participants' responses. When all of the item scores are added together, a maximum possible score of 124 is determined. Level 30 indicates a chance of fully or partially disagreeing, Level 40 indicates a chance of agreeing, Level 50 indicates a failure to go from partially to strongly agreeing, Level 70 indicates a strong agreement, and Level 80 indicates complete agreement (Gresse et al., 2014).

Data Analysis

The IRT framework measures how likely a respondent is to provide the correct answer to a given item, with the goal of raising the researcher's level of ability. It does this by analyzing the relationship between the researcher's performance on an item and their ability as described by the characteristic function of the item (or the response function of an item) with the respondent's response to the item (Rakkapao et al., 2016). Data were shown in tables and then compared within the framework of pertinent literature. The variables were examined using descriptive statistics, which included test mean, test frequency, test percentage, mean, and standard deviation. The SURE instrument's adopted scores were used to compare the usability test results. The fact that each rater's response to an item shows probability as a function of the item's parameters and capabilities ensures the data's reliability because it is based on IRT (Gresse et al., 2014).

RESULT

Participant Characteristics

Fifteen respondents participated in testing the development and usability of the application; they were nurses who have treated stroke patients; with the age range of 20 to 50.

Task Performance

We assessed respondents' performance and task completion in accessing the app based on the duration and level of app usage listed in Table 1. There is a difference in task 1 as it takes longer than the other tasks to download and installitation process.

All participants completed task 1 (downloading and installing the app), task 2 (filling out the questionnaire), task 3 (creating an account), task 4 (find home), task 5 (find and fill in screening data), task 6 (find position and time setting sensors), task 7 (find education), task 8 (find discussion forums or help). Downloading and installing applications took the longest time, followed by filling in questionnaire and creating accounts. Task 8 find a discussion forum or help center took the least time (Mortezaei et al., 2023).

Table 1. Participant task completion and time (n=15).

No	Tasks	Completion rate	Times
1.	Download and install application	15/15	21/14
2.	Fill in questionnaire	13/15	16/32
3.	Create account	15/15	13/26
4.	Find your homepage	15/15	2/40
5.	Find the data menu	15/15	5/27
6.	Find the position and time setting sensor menu	14/15	5/53
7.	Find video education	15/15	1/60
8.	Find the discussion or help menu	15/15	2/60

The results of the heuristic evaluation of the development and usability of the application by the respondents as users are shown in Table 2.

Table 2. Participant respond in each item *SURE Instrument*

Item	Score			
	1	**2**	**3**	**4**
1. I found it easy to enter data in these applications. For example, using QR code, picklist, etc.	-	1	10	4
2. When I make a mistake it is easy to correct it.	-	2	7	6
3. I found the help/tip given by the app to be helpful.	-	2	6	7
4. It was easy to find the information I needed.	-	-	9	6
5. I felt in charge using this app.	1	2	4	8
6. I found the time it took to complete the tasks to be adequate.	-	5	3	7
7. It was easy to learn how to use this app.	-	-	5	10
8. The sequences of actions in the application correspond to the way I usually perform them. For example, the order of buttons, data fields, etc.	-	2	6	7

9. It is easy to do what I want using this app.	-	1	6	8
10. It was easy to navigate the application menus and screens.	-	2	5	8
11. The app meets my needs.	-	-	7	8
12. I would recommend this app to others.	-	2	5	8
13. Even in a hurry I would be able to perform the tasks in this application.	-	-	7	8
14. I found the app consistent. For example, all functions can be performed in a similar manner.	-	1	7	7
15. It is easy to remember how to do things in this app.	-	2	5	8
16. I would use this app often.	1	2	5	8
17. The organization of menus and action commands (such as buttons and links) is logical, allowing you to easily find them on the screen.	-	1	6	8
18. I was able to successfully complete the tasks using this app.	-	2	6	7
19. I enjoyed using this app.	-	-	8	7
20. The app provides all the information needed to complete tasks clearly and understandably.	-	3	6	6
21. I found the app very complicated to use. (-)	9	4	1	1
22. Symbols and icons are clear and intuitive.	-	1	8	6
23. I found the texts easy to read.	-	-	7	8
24. I found the application unnecessarily complex. I had to remember, research, or think hard to complete the tasks. (-)	7	5	1	2
25. The terminology used in texts, labels, titles, etc. It is easy to understand.	-	4	5	6
26. I would need support from one person to use this app. (-)	2	6	3	4
27. I felt comfortable using this app.	-	2	6	7
28. The app behaved as I expected.	-	2	7	6
29. I found it frustrating to use this app. (-)	10	2	2	1

30. I found that the various functions of the application are well-integrated.	-	2	8	5
31. I felt very confident using this app.	-	1	6	8

Table 2 shows that a significant portion of the respondents selected "very poor" for some of the negative questions on this SURE intrument questionnaire. The application's menu was deemed extremely understandable by the remaining respondents, who also thought it was very straightforward to use.

Table 3. Scores obtained from end user assessments using the *SURE Instrument*

Participant	Total	Level
1	115	Totally agree
2	113	Totally agree
3	86	Totally agree
4	87	Totally agree
5	103	Totally agree
6	84	Totally agree
7	89	Totally agree
8	106	Totally agree
9	86	Totally agree
10	124	Totally agree
11	104	Totally agree
12	88	Totally agree
13	110	Totally agree
14	96	Totally agree
15	114	Totally agree

Table 3 lists each user's recommended assessment level for the SURE tool. Table 3 demonstrates that the average usability score is 100,3 with a range of 84 to 124. We therefore defined usability as a single level (80 = totally agree), which reflects the high degree of usability of the prototype.

DISCUSSION

What constitutes usability was widely agreed upon by users. Since they can enter and edit data with ease, they believe the app to be useful. These devices have comparable capabilities to what is currently on the market; the contents are clear and easy to understand; the interface is interactive and user-friendly; and the language used is accessible and understandable (Gresse et al., 2014). Users are unanimous in their assessment that the app provides exceptional support and guidance.

Hundreds of thousands of health- related apps are now available on mobile devices, targeted toward almost every conceivable health issue. Health apps have the potential to improve health outcomes, but some authors have called into question the veracity of information provided via such apps (Hensher et al., 2021). Becauseof the lack of definitions and information regarding the development and potential utility of health apps for users in the future, a variety of apps have been created, but many are ineffective and complex.

The HealthCare Information and Management Systems Society's criteria have been used to assess the usability of mobile health apps. Regarding the SinoBed app that we created, its primary goal is to lessen the severity of pressure ulcers. As a result, the timeline for shifting stroke patients' positions worries the sinobed application greatly. This software can remind nurses to move patients' beds by setting a timer that runs every two hours throughout the day. Thus, end users have a great interest in knowing whether a mobile app for monitoring pressure ulcers has high-quality attributes including functionality, dependability, usability, efficiency, compatibility, security, maintainability, and portability (Koepp et al., 2020).

Numerous usability models exist for mobile apps, however the majority have not been shown to be helpful and have not been fully examined. It will take a long time and prevent the respondent's mobile device from downloading the application later on if they have a mobile device but their memory storage is full. An application's download speed and installation performance are directly correlated with the amount of memory that the respondent's mobile device has available.

According to them, the app's color scheme, functions, and choice of icons displayed had an impact on respondents' enthusiasm for using it. The majority of them felt that the software needed some better functionality and that the colors were too muted. They clarified, though, that these were user recommendations. In addition, posture and non-posture data, together with humidity, temperature, and weight, should all be carefully considered when designing the position setting menu. Vital signs and test data could have been included in earlier studies using smart sensors to prevent pressure sores (Silva et al., 2022).

Sure Instrument provides usability test scores based on a Likert scale from 1 to 5, with description ranging from very poor to excellent. The methods used to evaluate health apps within published frameworks very greatly, and this variation creates continuous doubt about the best way to evaluate health apps (Hensher et al., 2021). There were 4 negative questions among the many positive questions. They denied that the application was difficult for questions 21 and 24, and stated that it was very easy to use. In response to the question of whether respondents needed help when using the program, they disagreed. Lastly, they refuted the statement that respondents would be annoyed by the software. The variation of the content of an application is one of the components that can ensure its usefulness. (Kebede & Pischke, 2019). Thus, user testing is crucial before constructing the application since it provides feedback on features and menus based on user needs. User testing is the foundation for developing the program before integrating the context entirely.

Study Limitations

The weakness of this study is a small sample population. We also didn't find any alternative methods to find out whether each participant read every question carefully when filling out the questionnaire.

CONCLUSIONS

Based on testing a very user-friendly prototype application, almost all of the respondents concur. When users encounter

no significant difficulties while completing a set of test requirements, it indicates that our mobile applications are well-designed to meet the needs of users and offer a high degree of effectiveness, efficiency, and satisfaction. Respondents will be in a better position to manage their patients' health since they will have easier access to monitor the patient's position and will be less likely to make mistakes by forgetting to adjust the position of a patient who is lying down.

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