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Software Testing of a Web-Based Apps for Human Vital Signs Monitoring System



Abstract: - Recent rapid advancement of telecommunications technology, contemporary software applications are easily accessible. Many individuals utilize applications, such as web or mobile apps, for information retrieval, financial transactions, entertainment, and healthcare purposes. An example application undergoing development is the Patient Monitoring App, a custom-made system designed to monitor an individual's health based on the Early Warning Score (EWS) system. Given the crucial role of software testing in the Software Development Life Cycle (SDLC), functional testing is imperative to identify and rectify potential issues in the app's development process. This study focuses on enhancing the application through meticulous functional testing, employing step-by-step test cases and usability tests using the System Usability Scale (SUS) to gauge user satisfaction levels. The overall functional test is promising where only 12 operations from 65 test cases (18.5%) for caretaker accounts and 12 operations from 67 test cases (17.9%) for admin accounts failed to meet the expected outcomes. This implies the functionality of the caretaker account is 81.5% and the functionality of the admin account is 82.1%. Notably, there were no discernible differences in performance across popular web browsers, namely Google Chrome, Microsoft Edge, and Mozilla Firefox. Usability tests involving 12 caretaker account respondents reveal an average total score of 68 out of 100, meeting the minimum acceptable value. In summary, functional testing has been instrumental in identifying errors and providing suggestions for app enhancement, while usability tests offer valuable insights into user satisfaction. Emphasizing quality as a top priority, both tests serve as reliable indicators and guides for improving functionality and usability in the Patient Monitoring App.

Keywords: Functional Testing, Usability Testing, Test Cases, Early Warning Score (EWS)

I. INTRODUCTION

In the midst of the Industrial Revolution 4.0 and in the 5G era, software applications are used on a large scale. Johnson et al in 2021 [1] reported in statistica.com that there were almost 3.97 billion internet users connected to world wide web in 2019 showing us the enormous usage of internet platforms. The impact of software applications on our society are tremendous. With the help of internet access and affordable mobile technologies, many of us leverage web or mobile apps for many purposes.

The Patient Monitoring Apps [2] is a web application under construction, designed to help track a person's health condition based on a scoring system called the early warning score (EWS). This EWS is calculated based on the values of human vital signs. The benefits of web apps are, not only it requires almost no storage space in client's device, but also it updates information instantly on the server side [3]. Monitoring the EWS of a person by recording one's vital signs aims to identify critical patients as well as those with potential health deterioration. There are many versions of EWS as [4] evaluated in their studies such as modified EWS (MEWS), Hamilton EWS (HEWS), VitalPac EWS (ViEWS), Scottish EWS (SEWS) and National EWS 2 (NEWS 2). The differences between these EWS is only on the parameters, as for example oxygen saturation (SpO₂) were in the ES mentioned by [4] except for MEWS. ‘

In Malaysia, according to Health Technology Assessment by Ministry of Health, there is no formal adoption of a single standardized EWS at national level that can be used across Malaysian health care system at present. Some has adopted EWS either original version or adopted version while majority hospital is still using a conventional observation chart with routine of four basic vital sign monitoring [5]. These vital signs are recorded manually in a pen-and-paper-based approach, thus are prone to errors and missing records. The shortcoming of paper charts includes an incorrect entry of the EWS values hence could lead to incorrect or improper treatment.

Patient Monitoring Apps is capable to auto calculate EWS with user able to view trend charts presented on the dashboard. The advantage of this apps compared to others is that it has two extra features which are appointment

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and surgical module that help users keep these details together with EWS record on a single platform. Hence, by using the Patient Monitoring Apps, not only patient should not be worried about missing recorded data, but appointment details and surgery schedules are now accessible on an apps. Apart from the design aspect, quality remains top priority. Therefore, it is crucial for the apps to undergo a series of software tests to enhance the software quality before it can be featured.

Table 1 shows some literature searches that contribute to software application and testing. [6], [7] and [8] are some literatures on web applications relates to health studies. There are a few researchers that contribute on an automated or electronic EWS such as [9], [10] and [11]. However, it was more on the electronic EWS efficiency itself rather than software development. There are few researchers that leverage software testing subject such as [12], [13] and [14]

Table 1. Literature Reviews

Reference	Application			Software Testing	
	Web Apps	Mobile Apps	Other s	Functional Test	Non-functional test
Getz et al. (2021)	✓				
Rao et al. (2021)	✓				
Martin et al. (2021)	✓				
Mestrom et al. (2019)			✓		
Wong et al. (2017)			✓		
Nice (2020)		✓			
Khan et al. (2020)		✓		✓	✓
Meng Chun et al. (2020)		✓			✓
Chaudhary and Upadhyay (2021)		✓			✓
Arthana et al. (2019)	✓				✓

Nevertheless, their focused were on mobile apps instead of web applications. Jaafar et al in 2022 [15] investigated user satisfaction testing on the using mobile apps for patient tracking system. Arthana et al. (2019) [16] are the only researcher found to discuss both topics on web application and software testing, even though the test was focused only on non-functional testing.

This paper aims to improve the apps by focusing on functional tests through a step-by-step test cases and usability tests that been conducted by System Usability Scale (SUS). Functional tests are performed on two types of accounts, namely Caretaker accounts and SUPERADMIN accounts. Essentially, this paper contributes to the literature, by functional testing that helps discover errors and on how user satisfaction can be measured.

II. PROCEDURE FOR PAPER SUBMISSION

Functional Testing

The overall testing methods are divided into two sets of testing as shown in Figure 1. The first setup is on the functional test and the second setup is on the non-functional test.

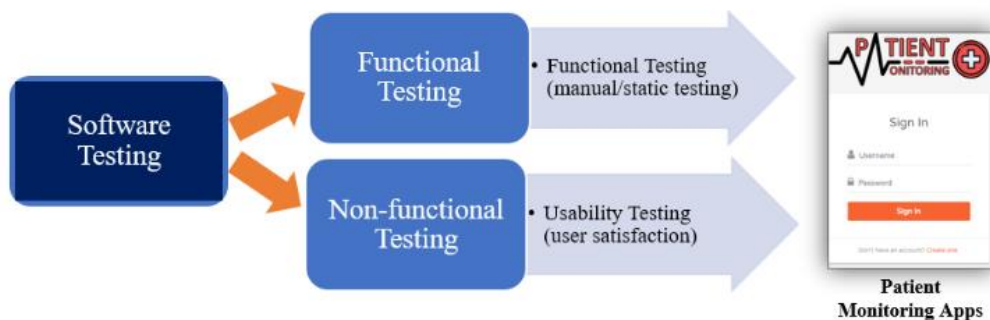


Figure 1. Overall methodology

Functional tests were performed on two types of account which are *Caretaker* and *SUPERADMIN* account. The process flow requires a few steps as shown in Figure 2.

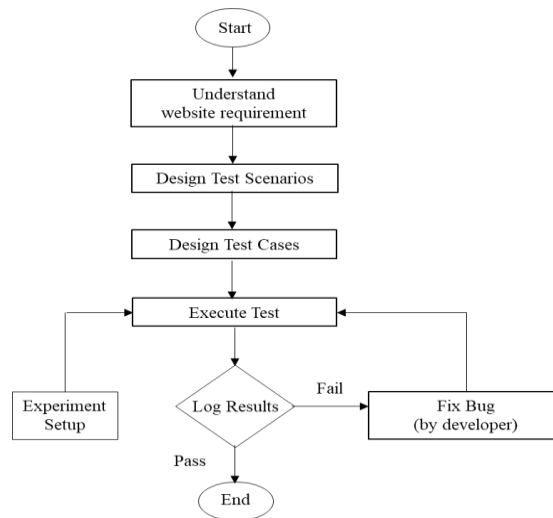


Figure 2. Functional testing process

Step 1: Understand website requirement

Familiarize the website structure and EWS score as guided by user manual.

Step 2: Design Test Scenarios

It is basically a documentation of a use case where it describes an action the user may undertake on a website. Test Scenarios are created to ensure that every single functionality offered by a website is working as expected.

Step 3: Design Test Cases

Test cases is a step-by-step approach comprises of ‘how’ and ‘what’ to test based on the test scenarios.

Step-4: Execute Test

Test execution is done based on the test cases steps, performed on different web browsers under the device setup as presented in Table 2.

Table 2. Device setup

Device Details	Laptop Specifications
Device Model	HP- Pavilion x360 Convertible 14
Screen Size	14" diagonal
Operating System	x64, Microsoft Windows 10 Version 10.0.19042
Processor	11 th Gen. Intel ® Core™ i5-1135G7 @ 2.40GHz, 4 Core(s), 8 Logical Processor(s)
Installed Random Access Memory (RAM)	8GB
Selected Browser(s)	Google Chrome, Microsoft Edge & Mozilla Firefox

Both test scenarios and test cases are tabulated in Excel spreadsheet. Figure 3 depicts a conceptual model of test scenarios and test cases use in this study.

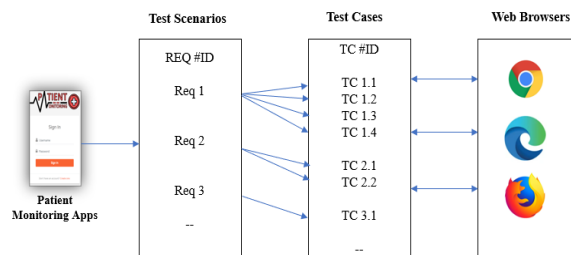


Figure 3. A conceptual model of test scenarios and test cases

Step-5: Log Results

The actual result is then logged in the test cases spreadsheet. The test is considered as Passed if the result output is as expected and Failed if it is not. The overall report then will be handing over to the developer for further rectification. The rectified bugs need to be re-evaluated and Step 4 need to be repeat until it is error-free. However, the repeat tests or validation of the verified bug will be not covered in the study.

Non-Functional Testing

The second part of testing is a non-functional testing which focus on usability measures. The goal of usability testing in term of satisfaction attributes is to measure user satisfaction towards the apps using System Usability Scale (SUS). In the context use, satisfaction refers to comfortability and acceptability towards the services. SUS is a usability tools, originally created by John Brooke in 1986 [17] and widely use with references over 1300 articles and publications [18]. SUS is able to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications [19].

SUS is consisted of 10 item questionnaires presented in a Likert Scale ranging from “strongly disagree” to “strongly agree”. It encompasses positives attitudes on odd question presented in number 1,3,5,9 and negatives attitudes on even question for number 2,4,6,8 as shown in Table 3. For the odd question, the contribution is the scale position minus 1, meanwhile for even question, the contribution is 5 minus the scale position. To get SUS score that ranges from 0-100, the score contribution from each item need to sum up and multiply by 2.5 [17]. The process flow for non-functional testing is shown in Figure 4.

Participants

Twelve participants (mean age 38 years) were assigned to take part in this survey. Participants who never use the application before were asked to do some tasks as to get familiar with the apps. Since there are some limitations to display the apps from a mobile phone, participants were asked to use only personal computer (PC), laptop or tablet to do the given tasks. After participants settled with the tasks, then they were asked to respond to the SUS questionnaires.

III. RESULTS

Functional Testing

The functional testing executed on both accounts brought satisfactory results where it has exposed few errors and some remarks or recommendations for further improvement of the application. The functional test (SUS) is presented in Table 4.

Table 3. SUS Questionnaires [17]

Item	< Strongly Disagree Strongly Agree >				
I think that I would like to use this Web Apps frequently	1	2	3	4	5
I found the Web Apps unnecessarily complex	1	2	3	4	5
I thought the Web Apps was easy to use	1	2	3	4	5
I think that I would need the support of a technical person to be able to use this Web Apps	1	2	3	4	5
I found the various functions in this Web Apps were well integrated	1	2	3	4	5
I thought there was too much inconsistency in this Web Apps	1	2	3	4	5
I would imagine that most people would learn to use this Web Apps very quickly	1	2	3	4	5
I found the Web Apps very cumbersome to use	1	2	3	4	5
I felt very confident using the Web Apps	1	2	3	4	5
I needed to learn a lot of things before I could get going with this Web Apps	1	2	3	4	5

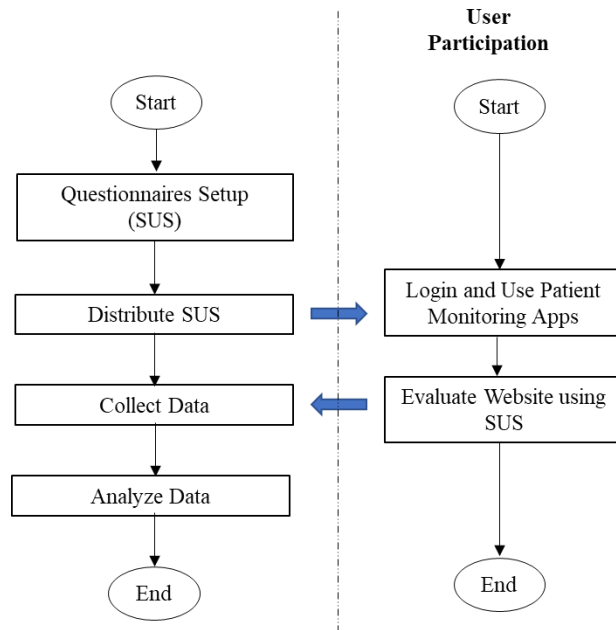


Figure 4. Overall process for measuring user satisfaction using SUS

Table 4. Functional test results for Caretaker and SUPERADMIN accounts

Test Cases	Passed	Failed
<i>Caretaker</i> account	53/65	12/65
Number of test cases: 65	(81.54%)	(18.46%)
<i>SUPERADMIN</i> account	55/67	12/67
Number of test cases: 67	(82.09%)	(17.91%)

Summary of Failed Results

The summary of Failed results for Caretaker account are as follows:

- i) To-go-back button seem to be activated even after logout operation, causing *Caretaker* (user) not able to maintain in the signing page. (Repetitive failed)
- ii) Error warning appear when *Caretaker* execute add button without completing the details in the ‘add new patient’ interface.
- iii) Able to add new appointment or new surgery schedule with invalid time.
- iv) When *Caretaker* edit their name in the ‘edit profile’ interface, *Username* in the signing page will change respectively causing user not able to sign in with their registered username.
- v) When form is not completed in add patient interface and user directly hit key-in EWS button, MEWS calculator appeared which is not the same interface with current EWS calculator. If user execute the process, the score was not recorded.

The summary of *Failed* results for *SUPERADMIN* account are as follows:

- i) Able to login with opposite letter case. Should be case sensitive.
- ii) To-go-back button seem to be activated even after logout operation, causing admin not able to maintain in the signing page. (Repetitive failed).
- iii) When *SUPERADMIN* edit their name in the My Profile interface, *Username* in the signing page will change respectively causing admin not able to sign in with their registered username.
- iv) *SUPERADMIN* has to be on individual patients’ page in order to export Score EWS for all patients.
- v) To-go-back button seem to be activated even after logout operation, causing admin able to edit EWS Calculator or download/export Score EWS’s file.
- vi) When user edited some info on *Caretaker* account, *SUPERADMIN* account which was open on another tab will change to *Caretaker* account.

vii) When logout was performed in SUPERADMIN page, Caretaker account which was open on another tab will auto logout.

Some of the remarks/recommendations for the said accounts:

- i) No option to access the web if user forgot the password (both account).
- ii) No confirmation or warning box if user accidentally click logout. It is good to acknowledges the user when leaving the apps (both account).
- iii) Picture icon should regards gender (both account)
- iv) No notification box appears if new patient is successfully added (Caretaker account).
- v) There is no warning box to notify user if the profile forms are not completed in fact "Whopps! There was an error" appeared (Caretaker account).
- vi) The vital graph able to display up to ten (10) data however the x-axis (date and time) displayed only five (5) (both account).
- vii) In Appointment and Surgery Schedule's page, if user input invalid date, the warning phrase appeared differently in Mozilla Firefox (Caretaker account).
- viii) In Edit Doctor Appointment and Edit Surgery Schedule's page, there are 'x' icon in date & time box in Firefox instead of calendar & clock icon for Edge & Chrome. When click on 'x' and hit update button, "Whooops! There was an error." appeared (Caretaker account).
- ix) Able to add new surgery schedule even the time is passed (tested with current date but with passed time) (Caretaker account).
- x) Username (Sign In) change when user edit Name in the profile. Suggested that any changes on the caretaker's name should not reflect Username on Sign In (Caretaker account).

Other observations:

- i) Recovery account and password are not possible since there is no option if user forgot their username/password.
- ii) No clear indicator of HOME for easier navigation.
- iii) No technical contact to refer to if user want to query or facing difficulties using the Apps.

Non-Functional Test (Usability) Result

SUS on Patient Monitoring Apps was aim to grade user experience on browsing and using the apps. These standard ten questions survey was targeted on 12 participants as [20] Tullis and Stetson (2006) indicate that sample sizes of at least 12 participants are enough to get reasonably reliable results.

The SUS on Patient Monitoring Apps was participated by three (3) males and nine (9) females aged range from 20 to 60. From the survey, 75 per cent of the respondents used laptop while the rest choose PC to browsed the apps. On the other hand, Google Chrome was the most chosen browser used by respondent.

The user satisfaction average score obtained from SUS was 68.1. The value was close enough to the average SUS score standard which is 68. This indicates that the system is adequate in terms of its usability but can be improved [21]. Corresponding to the comparison made by [19], SUS score 68 indicates user satisfaction in between OK and Good in terms of adjective rating.

IV. DISCUSSION

From the Functional testing results, it was observed that the functional test is capable of tracking errors where 12 operations which are found in each account that failed to deliver its functions.

From the summary of Failed results and remarks/recommendations, it was also found that there are similarities of error obtained in both accounts which some of the error relates to security features. As for Sign-In page, it should provide case sensitive password and put option for users if they forgot the username or password. In addition, the programmer must do thorough testing to ensure that users are able to maintain in the Sign-In page or by disable to-go-back or to-go-forward button so that no further operation can be done in Web Apps once user performed logout operation.

In terms of web browsers performance, it shows that all testing performed on different web browser manage to give almost the same output results except for a recommendation found in Mozilla Firefox where it displayed different warning box and different icon on date and time compared to Microsoft Edge and Google Chrome. On the other hand, SUS Scoring of 68.1 user satisfaction index indicate that this apps are acceptable but requires for an upgrade on certain functions.

V. CONCLUSION

In summary, it can be concluded that functional testing can discover errors and provide some suggestions that can improve the apps. On the other hand, usability test was able to give an insight to develop on which areas that need further enhancement. As quality should be maintained as main priority therefore both tests have provided a good indicator on how developers should enhance the Patient Monitoring Apps for a better functionality and usability.

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