Heuristic Usability Evaluation of Blood Pressure Mobile Application

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ABSTRACT

The usage of mobile devices for medical information is growing as mobile technology proliferates. Naturally, it is vital to first understand the causes of hypertension and hypotension before finding a way to maintain blood pressure in our body. It is relatively new for monitoring blood pressure through mobile devices throughout the modern age. The mobile industry is expeditiously developing and has a dynamic environment; hence, the User Requirements are bound to change from time to time frequently. Usability evaluation of mobile self-monitoring blood pressure is a new concern for research. As such, this paper evaluates the usability by benchmarking three monitoring blood pressure applications (BP: Info Diary, BP Log, and BP Journal), according to the ten usability heuristics developed by Nielsen (1994). The evaluation shows that the application comprises heuristic issues, like inefficient database access methods, sluggish application performance, ineffective fail-safe programming, inadequate error prevention, flow, and action duplication, slow to evoke from memory, unnecessary components(icons), hard to understand technical terminology (only appropriate for experts) and insufficient support for the in-app problem. The deficiency found gives supportive indications on improving the weakness in the application. The design of the three applications is somehow related to other mobile libraries; thus, the result is quite useful for many different health application developers.

Keywords: Heuristic, Usability, Self-Monitoring, Health application, Mobile devices, User Interface, Benchmarking

INTRODUCTION

Gadgets are advancing each throughout the year with more and more advanced technologies from before. Mobile devices have been an essential element of someone's daily life to commute or even to go through their day. People utilize mobile devices for social, entertainment, and educational purposes. It is handy for people to have everything right at their fingertips. The usage of mobile devices is being absorbed into a big company to make their product more accessible for people to reach. Mobile phone ownership has grown exponentially, and by the third period of 2017, more than one-third of users worldwide have mobile phones. Health is becoming more accessible for people to take

responsibility for. The health application market is expanding, with thousands of new health applications promulgated every year.

In 2016, about 100,000 new health-related applications were developed, following in a total of 259,000 health apps now available in major app stores (Meng Xiao, Xun Lei, Fan Zhang, and etc, 2019 “Home Blood Pressure Monitoring by a Mobile-Based Model in Chongqing, China: A Feasibility Study”). With the emergence of smartphones, more and more people are getting the chance to monitor their well-being and even diagnosing some mild conditions with healthcare applications. A survey conducted by Accenture shows that health app usage increased by almost 50% among consumers in 2016 compared to 2014 (Asher, 2015, "Losing Patience: Why Healthcare Providers Need to Up Their Mobile Game). Furthermore, patients and physicians agree on the implied perks of health apps.

The main areas of application development are chronic diseases like hypertension and diabetes. Hypertension is a global public health issue and is a gateway to the imposition of many conditions, including heart disease. 1 in 5 adults has hypertension, and 12.8% of cumulative deaths worldwide induced by high blood pressure. Hypertension is a lifelong disease that can affect to severe difficulties such as stroke and incurable kidney disease. Therefore, ongoing preventative supervision and regular superintendence of patients is essential in controlling blood pressure. Also, existing blood pressure applications can monitor hypotension or low blood pressure.

This paper is developed, as mentioned. After the introduction, we analyze the relevant work of this mobile app. Next, we define the methodologies in this study and present our findings on the comparative studies between the three designs, which are BPJ, BPID, and BPL. Finally, we finalize our conclusions and results.

RELATED WORK

The purpose of using mobile self-monitoring blood pressure (SMBP) is to facilitate patients with hypertension and hypotension to know and control their blood pressure. The app has useful features such as a logbook or diary features with three other functions: (Blood Pressure: Info Diary (BPID), Blood Pressure Log (BPL), and BP Journal (BPJ). The app facilitates the normalization of blood pressure measurements, while the reminder function can facilitate monitoring and compliance of medications. Besides, this health application also can provide valuable background information for patients on the disease, such as information on hypertension and hypotension, its treatment for this disease, how to measure blood pressure, and lifestyle management and ways to prevent it.

Analytical tools for self-monitoring blood pressure (SMBP), for example, graphs and flow analysis can provide an overview of your blood pressure journey from time to time. These tools also have BPID, BPL, and BPJ. Also, this application can export blood pressure readings that they already saved along with other user data via email, which allows patients to share their measurements with their healthcare providers, doctors, and relatives.

One thing that will be different between self-monitoring blood pressure (SMBP) and all of these apps is this app can save users' data through voice recognition; the user only tells the results of their blood pressure test to be stored in the application. The app will recognize the command from the users via Guided Command to save the result of the user's blood pressure. The user also can take pictures of the readings, and the application will recognize it and store it in the app by using a specific algorithm.

This feature can be considered futuristic, while the saved results will automatically be examined to the desired blood pressure. Some suggestions will also be

displayed to ensure that the user's blood pressure maintained to the desired level even though mobile applications could be used to help patients with hypertension or hypotension, least realized about the condition, features, and availability of mobile apps that target blood pressure. Thus, this study aims to systematically review applications to discover the function, variety, and availability of mobile applications that can be used to obtain blood pressure readings for further observation purposes.

This paper assesses the mobile application of BP as a case study. Based on our evaluation, recommendations for advancement are presented in this paper. As stated in the related work above, we are using heuristics evaluation and benchmarking of the assessment.

METHODOLOGY

HEURISTIC EVALUATION

According to Nielsen & Molich (1990); Nielsen (1992), Heuristic evaluation is a usability inspection method for identifying the usability problems of a user interface design. Based on the modification being made by Nielsen (1994) towards the heuristic evaluation method, 10 usability heuristics being proposed which are (i) visibility of system status, (ii) match between system and the real world, (iii) user control and freedom, (iv) consistency and standards; (v) error prevention, (vi) recognition rather than recall, (vii) flexibility and efficiency of use, (viii) aesthetic and minimalist design, (ix) help users recognize, diagnose, and recover from errors, and (x) help and documentation. Based on the ten usability heuristics, we apply them as a guideline in evaluating the usability of BP mobile application.

BENCHMARKING

We are also using benchmarking in the evaluation of the BP mobile application. According to Elmuti & Kathawala (1997), there are 4 types of benchmarking which are (1) internal benchmarking, (2) competitive benchmarking, (3) functional or industry benchmarking, and (4) process or generic benchmarking. In this evaluation, we are applying the competitive as we are comparing the BP mobile applications.

We are choosing BP mobile applications based on two requirements: (1) The rating of the mobile application, and (2) the number of users downloading the application exceeding 1000. There are 3 mobile applications are selected by us based on the requirements: (1) BP Journal - Blood Pressure Diary (BPJ), (2) Blood Pressure: Info Diary (BPID), and (3) Blood Pressure Log (BPL).

ANALYSIS - EVALUATION OF THE BP MOBILE APPLICATION

VISIBILITY OF SYSTEM STATUS

Nielsen (1994) suggests that the system should always inform users and receive proper feedback from the order within a reasonable time. BP Log provides "Add Records", "Reading", "Stats", "Export" and "Setting" services. For instance, users can update their blood pressure measurement regularly.(Refer to Fig.1 (a) and Fig.1(b)). They need to update more often their blood pressure reading so that they could measure and take the precaution of all the possibility that might occur to them. Whereas, BP Journal provides more service including “Add Reading icon", "Details", "Reading", "Statistics", "Charts", "Reminders", "Export & send", "Import", "Settings "and "Go Premium". BP Journal has "Go Premium" feature that will let the user buy some new extra features for them.(Refer to Fig.1 (c))

Furthermore, these apps will load up a welcome screen for first-time users. This

feature lets users explore and give more insight for the users before they use this app. This feature also would allow users to register. (Refer to Fig.8)

BPL **BPL** **BPJ**

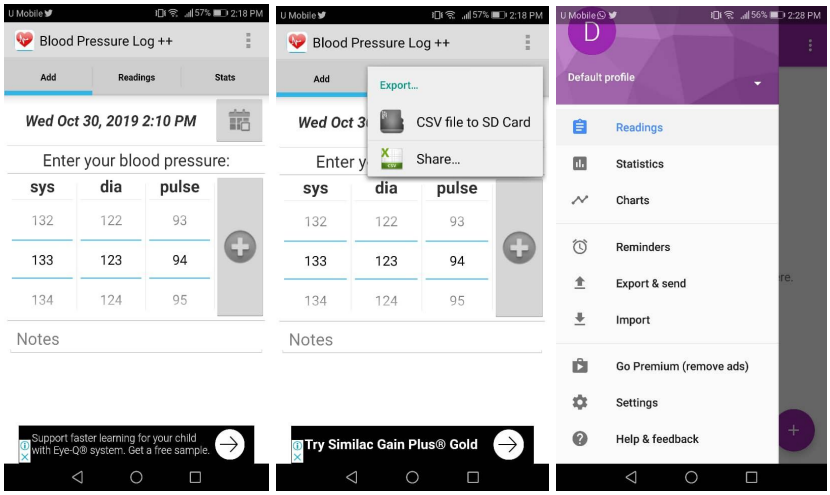

Figure 1(a) Figure 1(b) Figure 1(c)

MATCH BETWEEN SYSTEM AND THE REAL WORLD

Rather than utilizing framework situated terms, Nielsen (1994) proposed that a structure should use the language and ideas of its users and keep specific guidelines and a coherent request. BPJ does very well when applying the client language in the framework. It utilizes basic expressions that users know, for example, "reading" means the history of readings, "statistic" alludes the statistics given by the previous blood pressure measurement. "Charts" alludes the contact data to create charts and "Export" and "Import" indicates to transfer data to or from the application. The

BPL **BPJ** **BPID**

data of the BPID and BPL versatile pages aren't exactly as easy to understand as the BPJ. For instance, the BPJ and BPL do not have limits to set for the pulse where a maximum heart rate is about 220 minus his/her age, which may make clients misconstrue that the elements can't be acquired.

Nonetheless, the BPL doesn't provide stats for the first few data. When showing the opening times of stats, the data arranged aimlessly . Conversely, the versatile sites of BPID and BPJ organized all the more consistently. For instance, the BPJ gives the option to view many types of chart. BPID allows the user to view the stats and graphs in a line chart. (See Fig. 2)

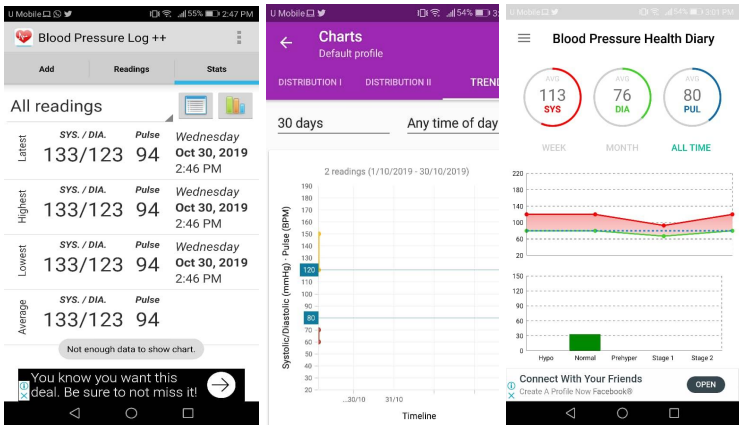

Figure 2

USER CONTROL AND FREEDOM

Users may accidentally select the system function. Nielsen (1994) suggested that systems ought to give an "emergency exit" for users to leave, just as help users to fix and undo/redo commands. All three applications: BPJ, BPID and BPL offers conventional design As an example, These apps have "Option (Three lines icon")"/ "Home Icon" and "Back" catches at the top, which enables users to return to the past page or the designated page (see Fig. 3).

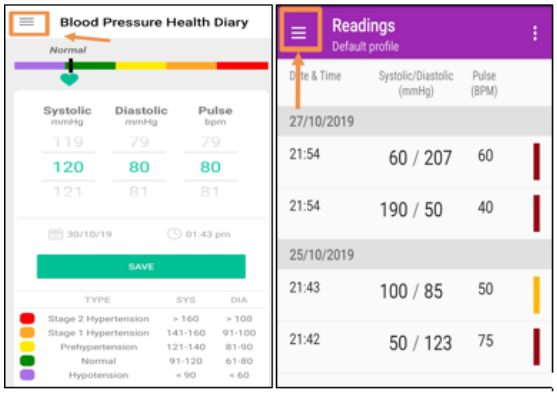

Figure 3

CONSISTENCY AND STANDARDS

Nielsen (1994) recommended that the substance of the framework ought to implement similarly. To a limited degree, BPJ can deliver a steady substance format. For instance, searching through outcomes is in a similar plan, including title, area, call number and thing status. (see Fig. 4 (a))

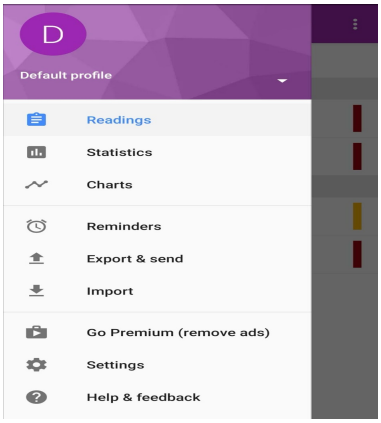

Figure. 4 a

The circumstance of the BPJ portable site is equivalent to the BPL. However, BPJ allows the users to input manually. Besides, BPL and BPID input data by using their given wheel (see Fig. 4(b)) . BPJ has a superior plan in creating steady substance compared to BPID and BPL.

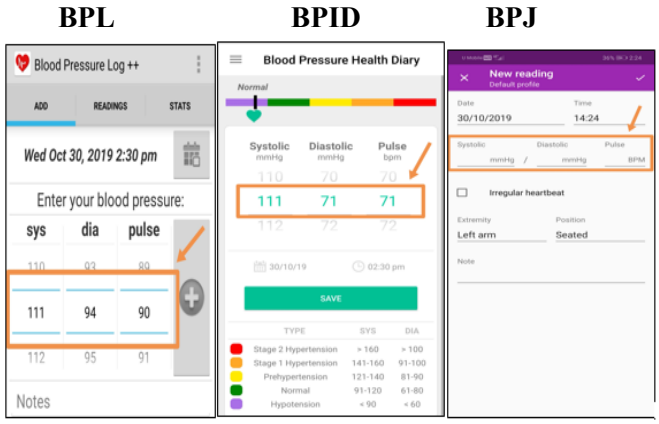

Figure. 4 b

ERROR PREVENTION

According to Nielsen (1994), systems should have careful design in order to prevent problems. The BPJ mobile app makes considerable efforts to prevent input error. For example, for the Reading section, it is easy to edit and delete data if there are wrong inputs. The user has to click the data, and it will automatically go to the ‘’edit reading’’, (see Fig. 5 a).

Besides, BPJ makes the reading more detail. For the first time user, they can choose to ‘’show the detail’’ by clicking on the three-dot on the right corner (see Fig. 5 b). Next, in the "Help" section, the BPJ provide online help which is there have an explanation about how to use this app (see Fig.5 c) in detail.

It gives instructions one by one and clearly and also it describes for every field name to make the user more understand. BPJ also give notes and tips for the user before they fill out the data. Compared with the mobile app of the Blood Pressure: Info Diary (BPID) and the Blood Pressure Log (BPL), the BPJ one has an inferior and exciting design in preventing errors. Other error-prevention functions mentioned in the BPJ, cannot be found in the BPHD and the BPL mobile app.

BPJ

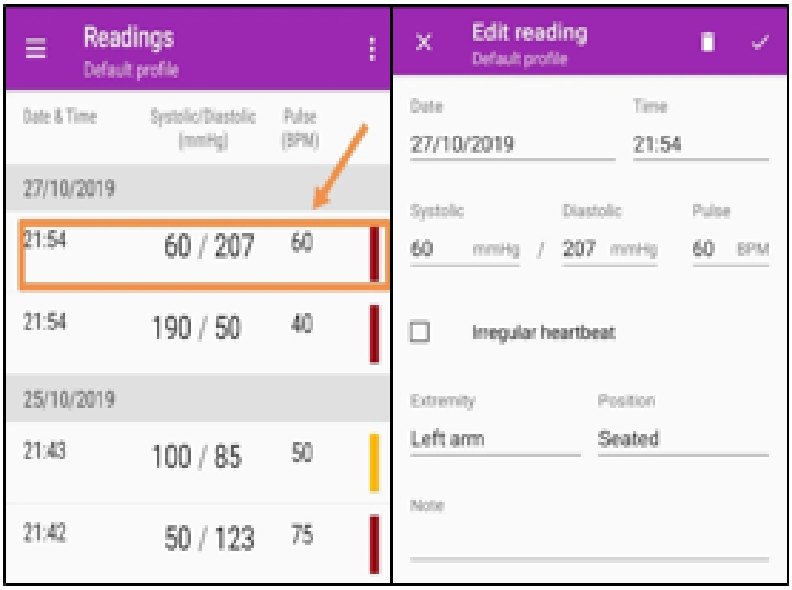

Figure 5a

BPJ

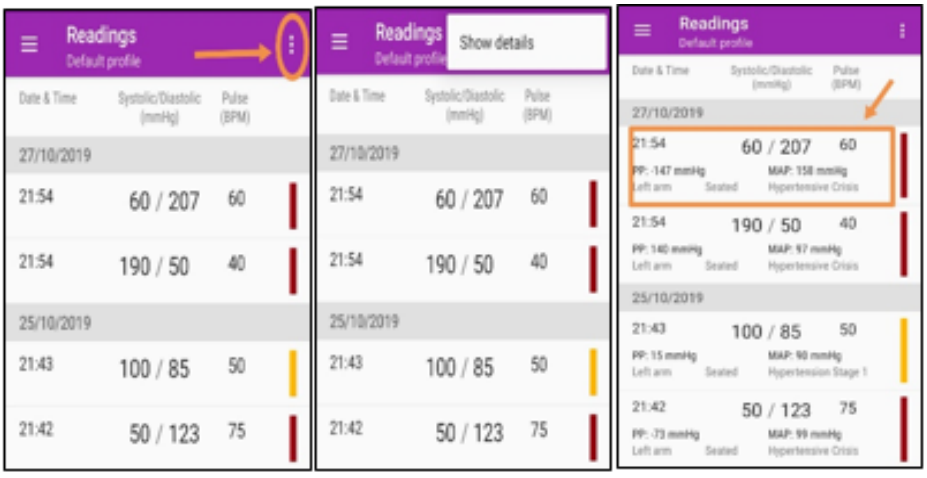

Figure 5b

BPJ

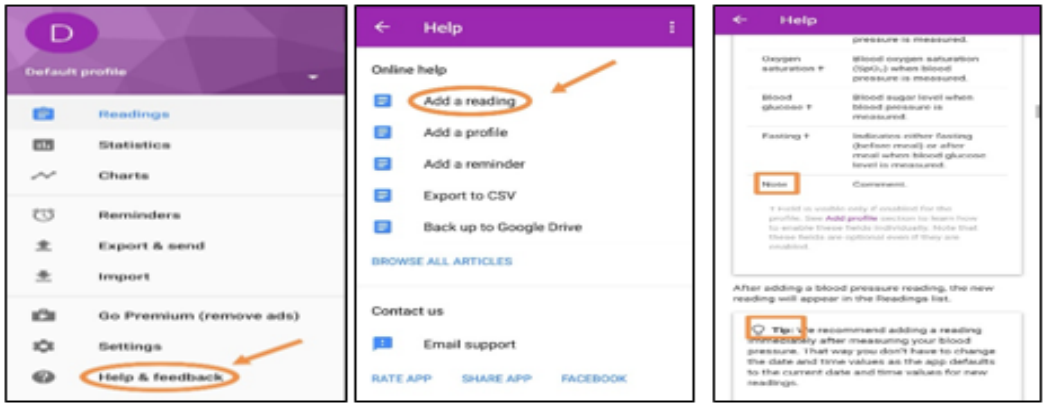

Figure. 5 c

RECOGNITION RATHER THAN RECALL

According to Nielsen (1994), systems should make objects, options, and instructions clear and visible so that users need not remember unnecessary information. The mobile app of the BPJ does quite well in this part. For example, on the statistical section of the BPJ, the instructions for entering time is put on the above (the period and time of day underlined) (see Fig.6 a) is clear so user easy

add the reminder. For BPID, the color of the number will be green if user want to have that number to be entered in data information (see Fig.6 c). In the mobile app of BPID, it will have a different colour stage of blood pressure to understand that ‘’period’’ and ‘’time of day’’ can be changed.

Same goes to the charts section. The user can change the ‘’period’’ and ‘’time of day’’. For example, the icon of the adding function of data for BPJ and BPL is big enough for users to notice and use easily (see Fig.6 b). Same with the reminders section in BPJ and BPL, it also uses adding an icon with the big size so users will know that icon is to such as ‘’red for stage 2 hypertension’’ and ‘’blue colour for hypotension’’ (see Fig.6 d), so the user can quickly know which stage they are. It shows that all three mobile apps have clear instructions for user easy to use

BPJ

Figure. 6 a

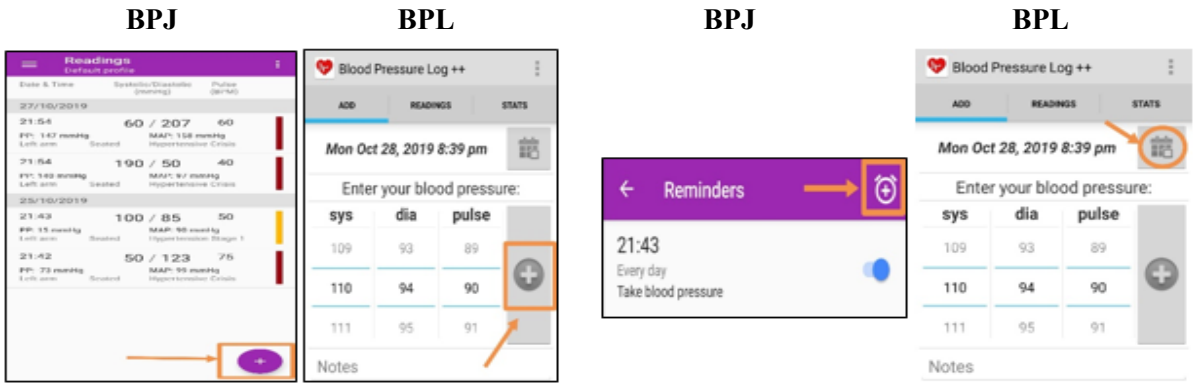

Figure. 6 b

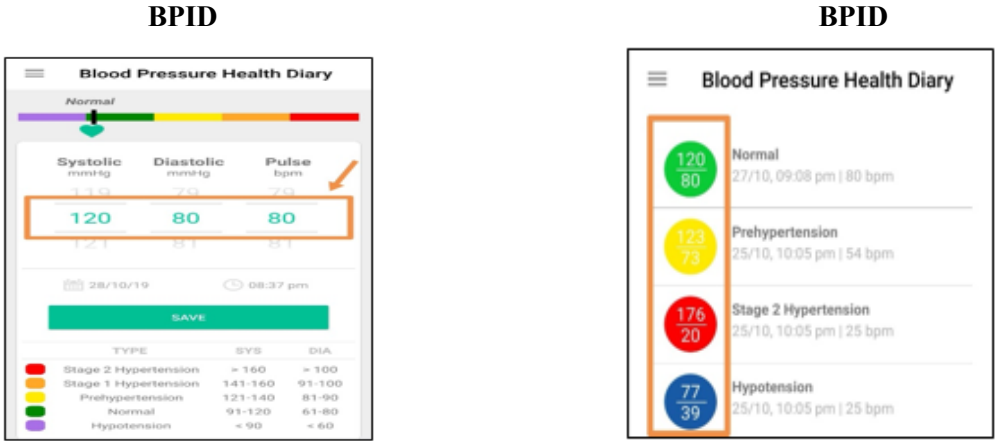

Figure. 6 c

Figure. 6 d

FLEXIBILITY AND EFFICIENCY OF USE

Nielsen (1995) suggested that systems should provide adequate services for both experts and inexperienced users with tailored options. Compared with the BPID and the BPL mobile app, the BPJ mobile app has an inferior design in this part. The BPJ mobile app does offer ‘’removed ads’’ functions for the user who wants removes ads so as not to interfere during the session (see Fig. 7 a). Besides, BPJ provides advanced options for expert users. For example, the BPJ allows users to choose their document (see Fig. 7 b) and also user can preview pdf of their reading chart.

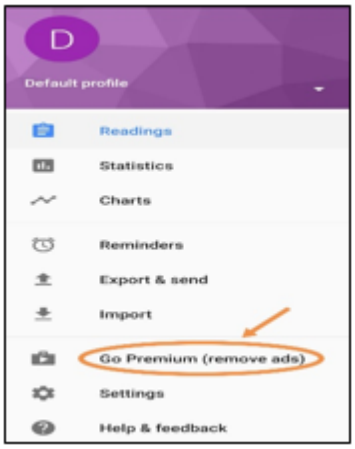

Figure. 7 a

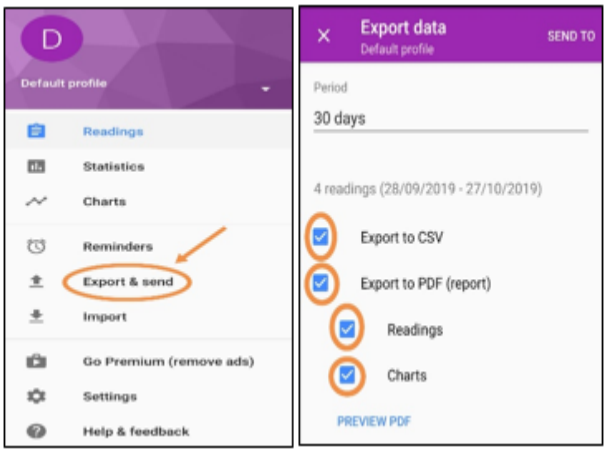

Figure. 7 b

AESTHETIC AND MINIMALIST DESIGN

According to Nielsel (1994), it is essential to keep the system from any excessive or irrelevant information for the user that may confuse them. The three mobile applications of the BPJ, the BPID and the BPL all produce an overall simple design without any excessive information. The use of simple wording and classification subjects in the mobile applications being utilized in it (see Figure 8.

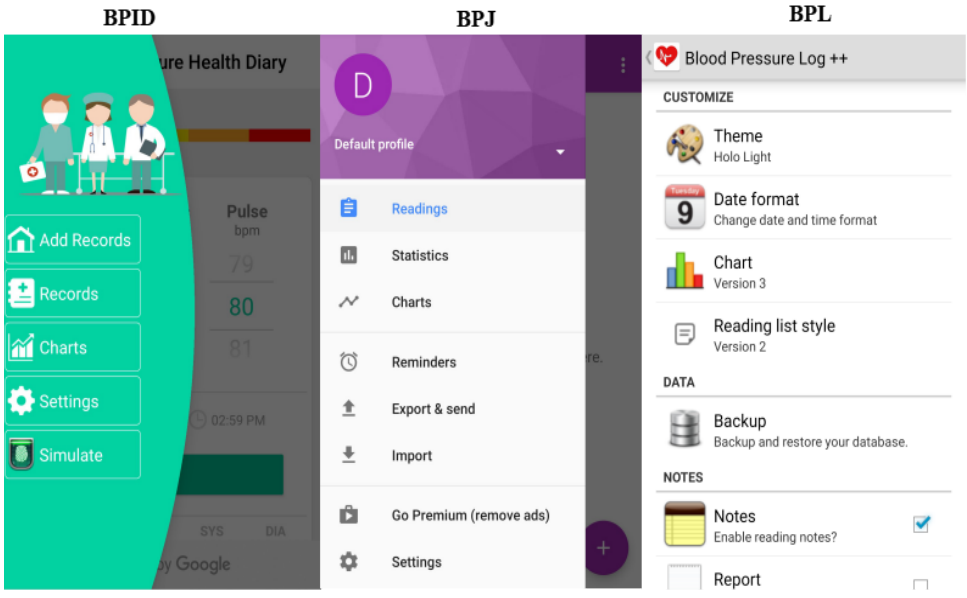

Figure 8

HELP USERS RECOGNIZE, DIAGNOSE, AND RECOVER FROM ERRORS

According to Nielsel (1994), the system must have an error message where it can be understood by the user, plus with the requirement of this heuristic which is BPID. The error message and solutions provided in the system is straightforward to understand and fix the problem. On the other hand, BPJ has both the error message and solution which is very hard to understand by the user due to lack of simple wording in the error message, but it provides a feature where the user can back up or restore the user's data. As for BPL, the system does not show any error message when the input from the user is illogical or any suggested solution to fix the error (see Figure 9).

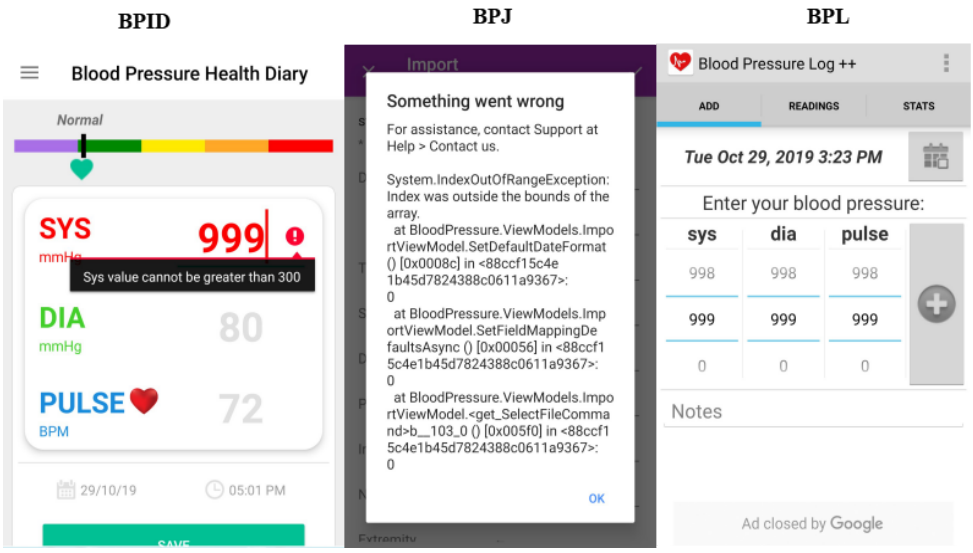

Figure 9

HELP AND DOCUMENTATION

In a system, the system must provide assistance toward the user that easy to search, focused on the user's task, and the list of concrete steps to be done (Nielsel, 1994). Overall, the mobile application that meets most of the requirements of this heuristic is the BPJ due to it provide the articles that can help n the user and the concrete steps to solve the problem while the BPID is only providing a small number of articles to help the user. As for BPL, there is no service provided to help the user, and the only way to ask any question is only by contacting the owner through email (see Figure 10)

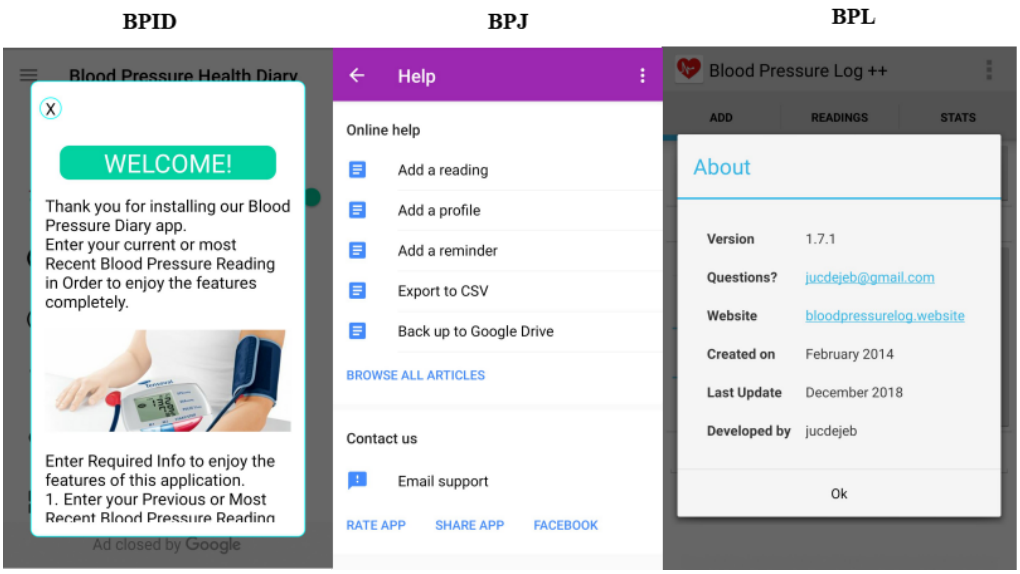

Figure 10

DISCUSSION

SUGGESTION ON IMPROVING THE BP

Based on the results of the comparative study, we discovered that the three of the applications (BPJ, BPID and BPL) have excellent design features. However, there are still some standard features that one of the application lacks and improvement that needs to be done to the applications.

First, the BP Journal application should improve in the context of visibility of system status, which is considered as average. The BPJ should improve by providing the menu to insert the blood pressure measurement directly instead of showing the readings of blood pressure, which could help in time efficiency of the user to be maximised. Second, both Blood Pressure: InfoDiary and Blood Pressure Log should make a consideration on user control and freedom. For example, the ability to edit or delete the data much more accessible. Our assessments results show that both of these applications only achieve an average score. 'Delete' or 'edit' the information that is being inserted should be asked before the data stored into the applications. This feature can help the user to have an accurate insertion of data since human error is unavoidable.

Several aspects need to be given much more attention to the three applications. The first issue is related to matching between system and the real world. For example, we found that statistic menu of the application can be quite complicated for some people since it on shows numbers. The option to show the charts is not visible to the user when two or less data is being inserted and need more than to be shown. Therefore, BPL should fix this issue and make sure that the statistic can be view in a graph that is easier to understand. Second, the BPID should pay more attention to the consistency of contents, such as giving the accurate reading of the blood pressure through the "simulate" feature in the application. We found out that that feature does not give an accurate reading of our blood pressure, rather than just a fun feature that could attract users. However, this feature is not proven to be accurate in any research that allows blood pressure checking application via smartphone. This feature also may give the user a piece of false information on their blood pressure reading. This feature can be improved by

doing the feature properly so that it can be read the right blood pressure consistently or by removing it directly.

CONTRIBUTION AND LIMITATIONS

This study contributes to both academics and practitioners. In academics aspect, this study contributes to the researchers of blood pressure to be able to apply the usability heuristics framework in the context of evaluating the blood pressure monitoring applications. For practitioners aspects, our findings allow them to develop a blood pressure monitoring applications in providing a better statistic of showing the blood pressure reading or any similar services such as blood pressure insertion menu.

Like any other research, this study has its limitations. The main limitation is that blood pressure can only be read from other sources such as blood pressure monitor machine. This limitation leads to the limitation of the user input into the application as they can only insert the blood pressure measurement from the machine and not directly being monitored through the application. Other than that, there have been more than five applications that shared similarities of the features.

Table 1

Summary of comparison between the three blood pressure monitoring application.

Usability heuristics	BPID	BPL	BPJ
Visibility of system status	❖ Can update data input ❖ Load welcome screen	❖ Can update data input ❖ Load welcome screen	❖ Can update data input ❖ Load welcome screen ❖ Has "Go Premium" feature
Match between system & the real world	❖ Applying the client language in the framework ❖ Lack of versatile page ❖ Has limit to set pulse ❖ Provide stats for few data	❖ Lack of client language in the framework ❖ Lack of versatile pages ❖ No limit to set pulse ❖ Does not provide stats for few data	❖ Applying the client language in the framework ❖ Has versatile pages ❖ No limit to set pulse ❖ Provide stats for few data
User control & freedom	❖ Offers conventional design	❖ Offers conventional design	❖ Offers conventional design
Consistency & standards	❖ Lacks of steady substance format	❖ Lacks of steady substance format	❖ Deliver a steady substance format
Error prevention	❖ Lacks of error prevention	❖ Lacks of error prevention	❖ Easy to edit and delete data ❖ Makes the reading more detail ❖ Provide online help
Recognition rather than recall	❖ Instruction easy to understand	❖ Instruction easy to understand ❖ ❖ Function of data for BPJ and BPL big enough to notice and use easily	❖ Instruction easy to understand ❖ Function of data for BPJ and BPL big enough to notice and use easily
Flexibility & efficiency of use	❖ Does not offer advanced searching for expert users.	❖ Does not offer advanced searching for expert users.	❖ Offer ‘’removed ads’’ functions ❖ Provides advanced options for expert users
Aesthetic & minimalist design	❖ Produces a simple design with relevant information	❖ Produces a simple design with relevant information	❖ Produces a simple design with relevant information
Recognize, diagnose, & recover from errors	❖ message and solutions provided in the system is straightforward to understand and fix the problem	❖ Does not show any error message ❖	❖ error message and solution which is very hard to understand by the user
Help & documentation	❖ Contact information is available ❖ Providing only small amount of article	❖ Contact information is available ❖ No service provided to help user	❖ Contact information is available ❖ No service provided to help user

CONCLUSION

In conclusion, heuristic evaluation and benchmarking methods are used to evaluate the usability of the blood pressure monitoring applications. The evaluation result shows the three applications have good traits in four usability heuristics (Nielson,1994), which is (1) user control and freedom, (2) recognition rather than recall and (3) aesthetic and minimalist design. However, we note that there are still a room for improvement such as (1) provide the visibility of the system status, (2) matching between the system and the real world, (3) give user the ability of control and freedom, (4) provide a much consistent data, (5) provide error prevention messages, (6) give solution to the error and (7) providing features to help user in need. As a result, some suggestions for improvement to the applications are being provided . Finally, we also discussed the theoretical contributions and practical implications of this study and the limitations of the research.

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