

HEURISTIC USABILITY EVALUATION OF WATER QUALITY DETECTOR USING MOBILE APPLICATION

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ABSTRACT

With the advancement of smart phone technology, the community in the world especially the students use the mobile devices for educational purpose. This mobile application technology must be participated by people especially student should try to expand their services and design the mobile application to meet user's needs. The history of mobile application came to bigger, especially in USA , China and Europe. Usability evaluation of mobile application is a new issue for study. As such , this paper evaluates the usability of VuTest , WaterBot and ZenTest according to the ten usability heuristics develop by Nielsen (1994). This report will also summarize the number of violations found in each of the ten heuristic categories such as visibility of status , match sys & world , user control & freedom , consistency & standards , error prevention , recognition not recall , flexibility & efficiency of use , aesthetic & minimalist design , help users with errors , and help & documentation. Finally this paper will give the total number of violations in the entire interface and report should close with some overall recommendations in improving the user interface. The design of the water quality detector application is quite similar to other water quality application and thus, the results are quite useful for communities.

Keywords : Usability , Mobile website , Water Quality , Heuristic evaluation , Benchmarking , User interface , Mobile device , Mobile phone.

INTRODUCTION

Smartphone is one the most important thing that an individual should have beyond their reach at all time, especially for youngsters. It is often used by peoples for social, entertainment, and even educational purposes. They use their devices to take photos, listen to music, access the Internet, keep track of their fitness schedule, play mobile games, chat with friends through mobile apps, and many more bile devices for social, entertainment, and even educational purposes. The share of Americans owning smartphones has increased substantially since 2011, when Pew Research first began examining smartphone applications. Today, almost two-thirds (64%) of adults in the United States have a smartphone, up from 35% in 2011. Young adults and those with higher education are among the most likely to have a smart phone [1]. Meanwhile, in Malaysia, based on 2017 Malaysian Communications and Multimedia Commission (MCMC) Hand Phone Users Survey, the amount of smartphone users continues to rise. The rate of the users grew by 7.2% from 68.7% in 2016 to 75.9% in 2017 [2]. In America, about sixty percent (62%) of smartphone owners used their phones to get health information last year, same as the percentage who said they had used their smartphone for online banking. Americans not only use their smartphones to find employment information, but they also use their phones to apply job [1]. In Malaysia, since 2012, the percentage of smartphone users in use their phones for Internet access increased by 26.0% [2].

Mobile health applications have become a vital tool to make our lives

healthier. In 2017, over 75% of active smartphone users open their health & fitness app at least twice a week. More than 25% of users access their fitness app more than 10 times a week. Since 2014, there are huge growth in the health & fitness applications category. Within three years, consumption increased by 330%. However, since 2016, growth has been slow. There was an annual increase of 178% from 2014 to 2015, the health & fitness applications category grew only 9% from 2016 to 2017 [5]. However, most of the people that own a smartphone doesn't aware of water quality applications. This is because on the urban areas, they have access to clean water that makes the user thinks the water quality application is useless for them. As for rural area, people find it difficult to trust the application as they thought the application is fake. Basically, they will go to the department of water quality to test the water quality. Furthermore, water quality application is hard to find on the mobile application store.

In this research, we develop a study on evaluation and comparison in three water quality applications that we found on the mobile application store. The three mobile applications are VuSitu, ZenTen and WaterBot applications. These applications are designed to examine and monitoring the quality of water by defining the pH of the water, the temperature and many other functions. These applications use a water quality detector to measure the quality of water by using Bluetooth connection. There are various usability features available that were originally developed for the graphical user interface on desktop computers. Among the most popular are the 10 Nielsen heuristics, the

eight Shneiderman rules or the ergonomic criteria defined by Scaplen and Bastien. For this research, we evaluate these applications based on the 10 usability

heuristics for user interface design by Nielsen (1994).

LITERATURE REVIEW

MOBILE APPLICATION AND WATER QUALITY MOBILE APPLICATION

Mobile applications consist of software or set of programs that run on mobile devices and perform specific tasks for users. Mobile applications are a new and rapidly growing segment of the global Information and Communication Technology. Mobile applications are simple, user-friendly, inexpensive, downloadable, and can be run on most mobile phones including low-end phones and phones. It is one of the portable technologies that helps users easily interact with the built-in system. Mobile application were able to provide constant connectivity, location-aware, limitless access, and interactive capability. Moreover, mobile application using standard developer tools, such as High level language programming and JavaScript, so that users can access the mobile application easily[6].

Due to the advantages of mobile applications, more and more water quality application have developed compared to before. For example, Universiti Teknikal Malaysia Melaka implemented a mobile application, which provided information about water quality [7]. As a result, they were able to provide information effectively to users. There were many other reports indicating the usefulness of water quality mobile application.

USABILITY EVALUATION AND MOBILE APPLICATION EVALUATION

There are many definitions of usability, and the most widely used definitions are introduced by Nielsen (1993) and ISO (1997). According to Nielsen, usability can be identified as five attributes: efficiency, satisfaction, learnability, memorability, and error [9]. ISO defines higher usability as "the ethos of producing products that a particular user can use to achieve a particular goal with effectiveness, efficiency, and satisfaction in a specific use context"[11]. Usability is considered one of the key elements for Web applications. Therefore, different methods of assessment have been proposed and can be divided into three categories: usability testing, usability testing and usability [12,13,14,15].

However, some researchers found that certain usability evaluation method were for the mobile applications, and only few methods are useful. According to Zhang and Adipat, traditional usability methods wasn't suitable enough in evaluating mobile context due to changing of environment and individual needs [16]. Some researchers recommend adapting heuristic evaluation, which is one of the usability inspection methods for mobile context [17,18,19]. While other researchers applied heuristic evaluation to test the usability of mobile application. For example, Monkman and Kushniruk and Neto and Campos applied heuristic evaluation method to evaluate a mobile

health application, and tablet applications, respectively [20,21]. Diaz, Harari, and Paola used heuristic evaluation to test the mobile interface of an educational website [3]

USABILITY EVALUATION OF WATER QUALITY MOBILE APPLICATION

Although numerous research can be found in studying mobile usability evaluation, there have been very few studies on evaluating the usability of water quality mobile application. Most of them used usability testing methods to evaluate the water quality mobile application. For example, National Hydraulic Research Institute of Malaysia (NAHRIM) used usability testing to evaluate water quality for Rainwater Harvesting System products in 2014. Universiti Teknikal Melaka has conducted two research of water quality which using mobile application in 2017[6][7]. Plus, Universiti Teknikal Melaka applied usability testing method to evaluate the mobile application of water quality mobile application using 3G network in order to help redesign the mobile application. [6]

RESEARCH GAP

To conclude, there are only a few research studies conducted for evaluating the usability of water quality applications. Mostly the research studies are conducted in countries such as USA and Canada. There are almost none conducted in Asia. This is because most people are not aware about the water quality applications. This is because people think water quality applications is not as important as other health applications such as diabetes

monitoring or fitness tracker application. Further, the advancement of mobile device with larger screen and equipped with powerful processors that is almost powerful as desktop processor, the rapid diffusion of low-cost high-speed mobile Internet in the Asia, the increasing amount of people that use smartphone to surf Internet every year, makes it worth to examine usability issues of mobile applications. Based on CNBC, it is estimated almost three quarters (72.6 percent) of internet users will access the web solely through their smartphones by 2025, equivalent to nearly 3.7 billion people [10]. Therefore, this research seeks to bridge the gap between usability assessments and water quality mobile applications under contemporary mobile technology, and to contribute to current and future research.

METHODOLOGY

This paper evaluates the three mobile applications, ZenTest, VuSitu and WaterBot as case studies, and provides suggestions for improvement based on our evaluation. As motivated by the literature above, we use heuristic assessment and benchmarking for evaluation.

HEURISTICS EVALUATION

Heuristics evaluation is a method to identify the usability problems of a user interface design. Nielsen [1992] modified the heuristics evaluation method and suggested 10 usability heuristics 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.

Heuristics evaluation has many benefits such as, cost, speed, and conciseness. Because of the benefits, we use the heuristic evaluation method as a guide to assessing the usability of the ZenTest, VuSitu and WaterBot mobile applications.

BENCHMARKING

Benchmarking is used for evaluation to help analyze all three mobile applications, ZenTest, VuSitu and WaterBot. Therefore, benchmarking is a tool for improving performance. Benchmarking highlights problem areas and the potential for improvement, providing an incentive to change, and assists in setting targets and formulating plans and strategies. There are 3 types of benchmarking: Sector benchmarking, Generic benchmarking, Best practice benchmarking.

Competitive benchmarking is utilized in this project as it is typically used with competitors in the same field. Competitive benchmarking is used in this project as it is commonly used with competitors in the same field. Due to its high reputation and more functionality, the ZenTest mobile application was selected as the best practice reference among other two mobile applications. Besides that, VuSitu and WaterBot mobile applications help to compare and

determine the advantages or disadvantages of each mobile applications.

ANALYSIS — EVALUATION OF THREE MOBILE APPLICATIONS

Three available smartphone applications are integrated and evaluated iaitu VuSitu, WaterBot and ZenTest related to water quality detector applications, according to the 10 usability heuristics developed by Nielsen (1994). The findings are as follows:

VISIBILITY OF SYSTEM STATUS

Nielsen (1994) suggests that users should always be informed by the system and receive proper feedback from the system within reasonable time. . All the three mobile application keeps users informed. For examples in VuSitu mobile application . “Connect” , “Live Readings” , “Data Files” , “Location” , “Low-Flow Testing” , “About VuSitu” , “VuSitu FAQs” and “Call Tech Support” are available for users to select. In WaterBot, the display provided “Home” , “My Account” , “Connect WaterBot” , “Support Tickets” , “FAQ & Manual” , “Logout” and “User”. Both application provide user manual to instruct the user. User who not familiar to use the application can learn from the manual that provided that cannot found in the VuSitu and WaterBot. Both the VuSitu and WaterBot display the services of water quality in mobile application but VuSitu didn’t provide information of user in using the application.

In ZentTest , “Measure” , “Calibration” , “Data” , “Settings” and “Information” ” are available for users to select. Therefore, users can know what services that ZenTest has provided but its doesn’t have any manual to instruction the user like VuSitu and WaterBot. Moreover, these three mobile application do not inform users of the search bar or search navigation . The application must provide search bar with the icon “Magnifying glass icon” that is other normal application. People want to search some detail or function in application easily by only using search bar. All the information that we search in the application by typing the keyword will appear. That’s make interactive communication with the user and applications.

MATCH BETWEEN SYSTEM AND THE REAL WORLD

Rather than applying system-oriented terms, Nielsen (1994) suggested that a system should use the language and concepts of its users as well as follow real-world rules and a logical order. These all mobile application VuSitu , WaterBot and ZenTest does quite well in applying users language in the system. In VuSitu , it uses simple wordings that users are familiar with, such as “Connect” mean application and sensor devices connection , “Live Readings” refers to the current data readings, “Data Files” refers to the information of data stored, “Location” means the exactly current location reading , “About VuSitu” means the information of the application , “VuSitu FAQs” means the giving basic information or manual for users and “Call Tech Support” means range services companies provide to their

customers for products. In WaterBot, “Home” mean application and sensor devices connection , “My Account” refers to the personal account application of the user, “Connect WaterBot” refers to the application and sensor devices connection, “FAQ & Manual” means the giving basic information or manual for users , “Logout” means the instruction the user to an act of logging out of a application system and “User” show the identification information of the personal using application. In ZenTest, “Measure” mean refers to the current data readings, “Calibration” refers to the application and sensor devices connection , “Data” refers the information of data stored, “Settings” means the application configuration and “Information” means the the information of the application. However, certain ZenTest and WaterBot does not provide all of its information in a clearly way.

In ZenTest , it provide “Low-Flow Testing” that the new user didn’t understand what that function can do also in WaterBot show the function that the user cannot understand like “Support Tickets”. All this function have many meanings can misunderstood to the new user. The application must have the easiest terms that provide the user especially new user to understand the function do.

USERS CONTROL AND FREEDOM

Users can accidentally select system functions. Nielsen (1994) proposes that the system provide an “Emergency exit” for the user to leave the page and supports the user to cancel and change the instruction. Compared to the mobile apps of VuSitu, ZenTen, and WaterBot, the ZenTen has the best design based oh this

heuristic evaluation. For example, all of the applications have the “Emergency exit” button or logo button at the top, that allows users to go back to homepage immediately or navigate through another feature on the application even when the user is filling up a data. Furthermore, most of the applications user installed are required for us to sign up an account for the applications. After logging into our account, we often accidentally pressed “Log Out” button displayed on the application. In ZenTen applications, if the users pressed the “Log Out” button, a pop up appeared to confirm users that they want to log out of the account. This feature

is very useful if the user accidentally presses the button. Unfortunately, for VuSitu application, there is no feature to log into an account.

On the contrary, all the applications must make improvements in this part. For instance, when logging or signing up into account on ZenTen and WaterBot applications, the “Reset” button are not available for the users to clear up the wrong data that they had filled up. This makes the user’s time wasted on clearing every data that they had filled in. As for the VuSitu application, the “Reset” button is not available when the user entering data.

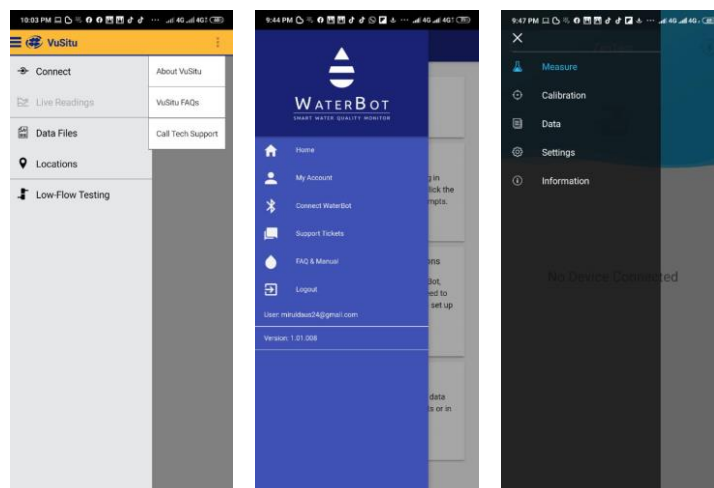


Fig. 1. Visibility of system status.

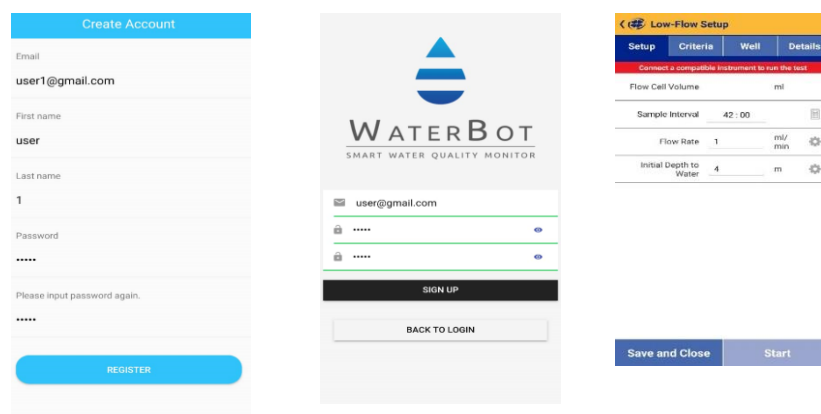


Fig. 2. No reset button available on the page

CONSISTENCY AND STANDARDS

Nielsen (1994) suggested that the contents of the system should be displayed in the same manner. All the applications are able to produce consistent content layout. For example, the features are all in the same layout and position throughout every page. This makes user easy to remember the order of the icons and finish a certain task more quickly and efficient.

However, some flaws can still be identified in the mobile application. Some of the pages displayed in WaterBot applications are absence of 'Emergency exit' or logo button. User could have a hard time to remember to recognize the symbol to undo a certain process. This can be classified as inconsistency problem.

Compared with the ZenTen, VuSitu and WaterBot applications, the VuSitu's has the best design in producing consistent contents.

ERROR PREVENTION

According to Nielsen (1994), systems should have a careful design in order to prevent problems. The VuSitu

mobile website makes considerable efforts to prevent input errors. In the data files, VuSitu mobile application makes considerable efforts to prevent input errors. For example, it produces a "Save to" button to save the data files in any platform. The platform that VuSitu provided are VuSitu Folder, Google Drive, Bluetooth, Email and Gmail. Users can click on them to save the data files easily not just using the database used by the VuSitu platform. This helps avoid input errors from missing and make extra backup saving data files.

Not like VuSitu, the mobile application of the WaterBot and ZenTest didn't have another extra platform to save the data file. The save file data button didn't provided in this application and only using the WaterBot database in saving the data files. To check the previous of data the user must open the application and open the history. All the previous data have been save in the application. The probability data files from missing is high and the developer must take another option to make a backup data files savings platform in the application to helps avoid input errors.

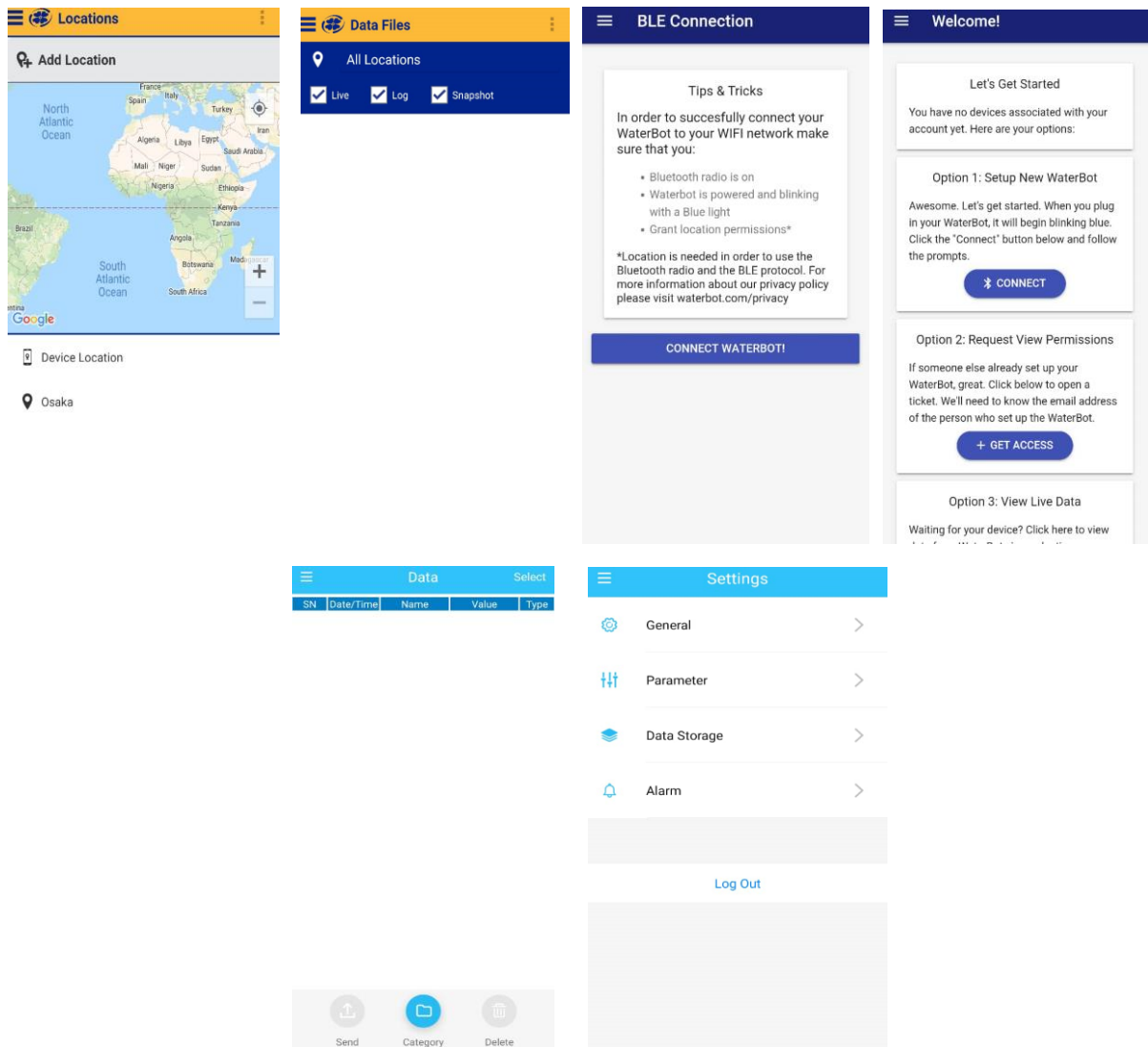


Fig. 3. Consistency in content layout

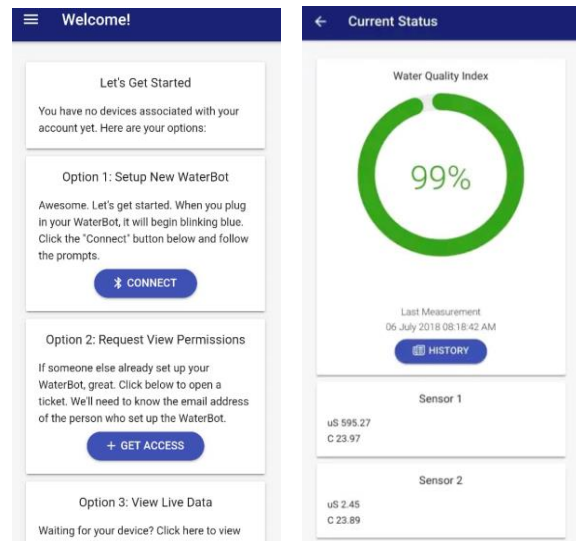


Fig. 4. Inconsistency in homepage button for “Emergency exit”

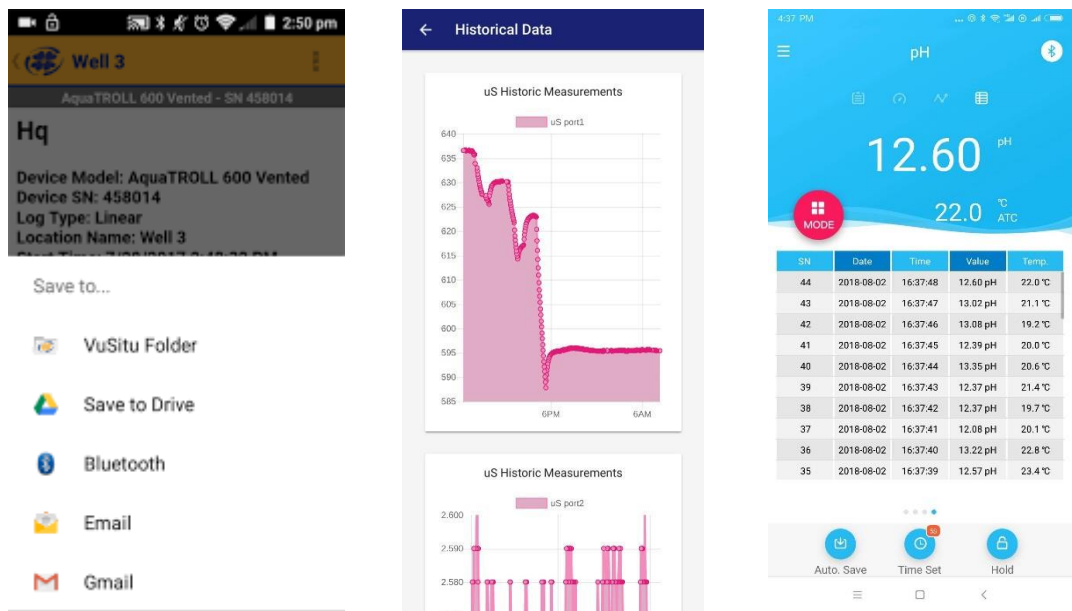


Fig. 5. Data File Saving

RECOGNITION RATHER THAN RECALL

According to Nielsen (1994), systems should make objects, choices, and instructions clear and visible so that users do not have to remember unnecessary information. For example, on the page of VuSitu, the icon on the top left show the logo of the application followed by the page name. For ZenTen, the page name is displayed at the top centre of the page while for WaterBot application, the page name is displayed beside the home icon. This makes the user easy to recognize what page they been displayed.

On the menu list of the three applications, icons related to the page are displayed followed by the menu list. This make the users easy to understand what the objective of a specific menu list is. The global home icon on each page on the applications also make user understand the meaning of the icon. However, VuSitu and WaterBot application need to make some improvement in their design. The icons in menu list should have been highlighted with different colour from the menu list based on the page that the user choose. This can prevent the user from

choosing the same options on the menu list.

Based on the heuristic evaluation, ZenTest have good design that fulfil the requirements. When user go to a specific page, the icon and the page name displayed in the menu list become light blue shows that the page that the application been displayed.

FLEXIBILITY AND EFFICIENCY OF USE

Nielsen (1995) proposes that systems should provide effective services for both inexperienced and experts users with customized options. Compared with the Zentest and VuSitu mobile applications, WaterBot has weakness with the application design in this part. The WaterBot mobile application does not offer data view function for expert users. Only a simple final display that is available. However, other both applications provide advanced how to view data for expert users (see Fig. 8). For an example, ZenTest and VuSitu allow users to choose which data they want to see while WaterBot allows users to view only at the final outcome display.

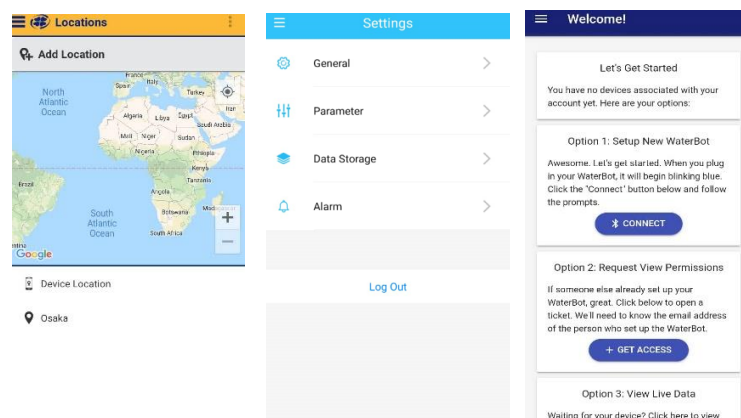


Fig. 6. Icon of homepage and page name that ease the users to page that had been displayed

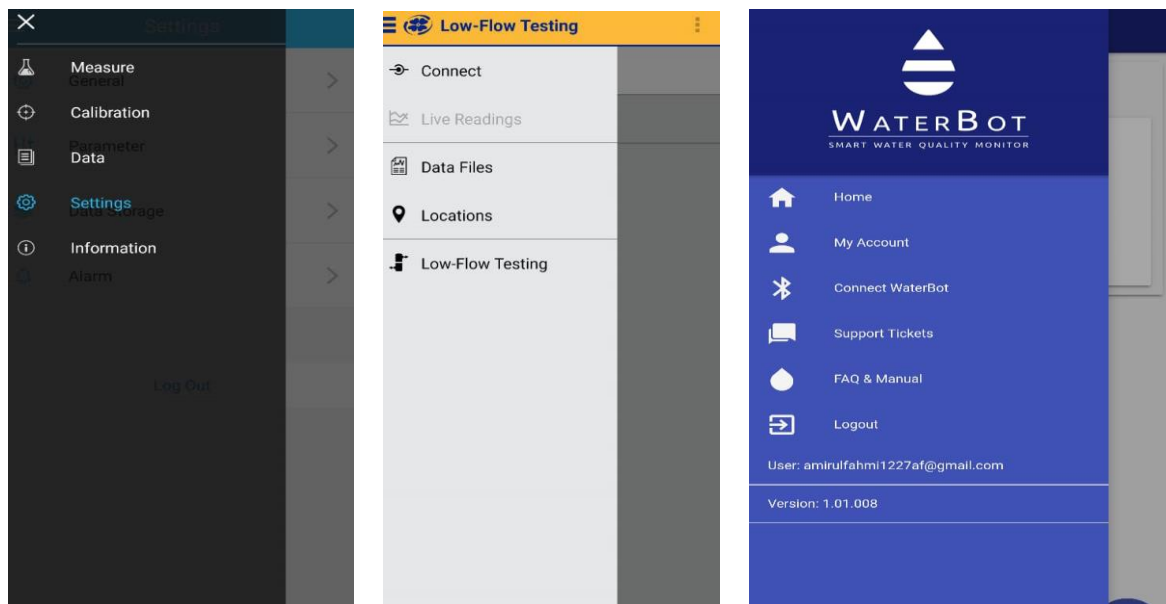


Fig. 7. The page that user selected is highlighted in the menu list for ZenTen application but not for VuSitu and WaterBot application.

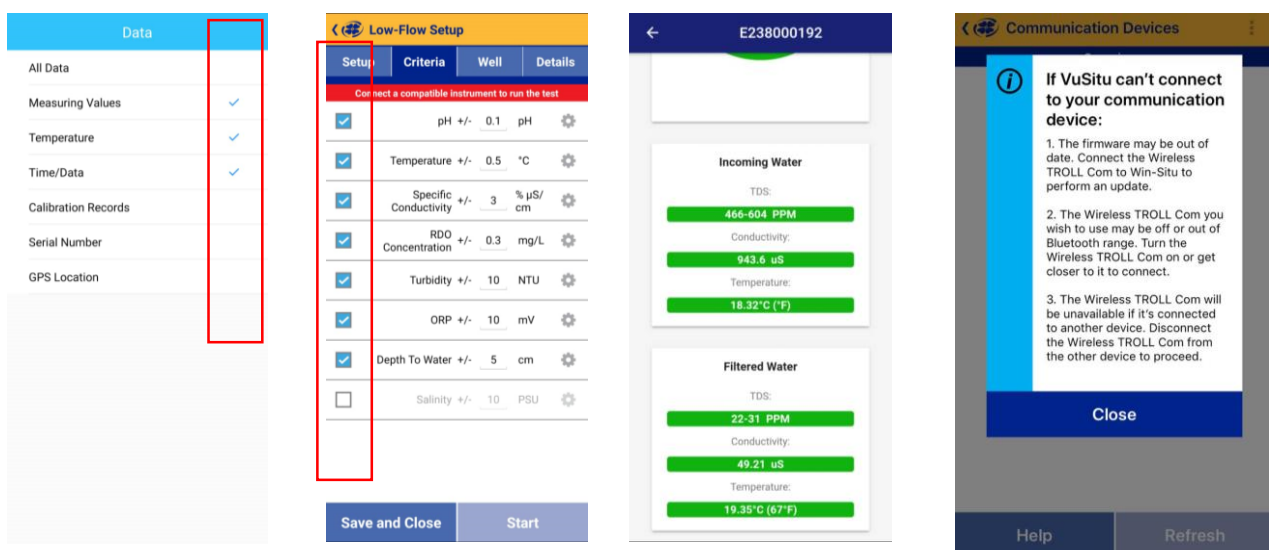


Fig. 8. Flexibility And Efficiency Of Use

AESTHETIC AND MINIMALIST DESIGN

According to Nielsen (1994), the system should avoid excess and irrelevant information because it would confuse the users. The three mobile applications ZenTest, VuSitu, and WaterBot have a very simple overall design with relevant information without irrelevant materials. But to conclude ZenTest has the most simple design but with complete information compare to other two mobile applications. Simple wordings and categories of subjects are easy to recognize by users.

HELP USERS WITH ERRORS

In the system, the error messages need to disclose the problems and suggest

solutions for users (Nielsen, 1994). However, three mobile applications of the Zen Test, the Vu Situ, and the WaterBot are unsatisfactory in this aspect. For instance, when users entering incorrect specification such as a phone number, the application does not correct it or show error for that data. The wrong data just saved by the mobile application which is wrong and not applicable for the user data requirement. All three mobile application shows the same problems in the required data section but those three only shows pop-up notification on log-in section when it comes invalid email or password and connectivity with the devices. The error messages are not supportive and cannot help users recover from errors.

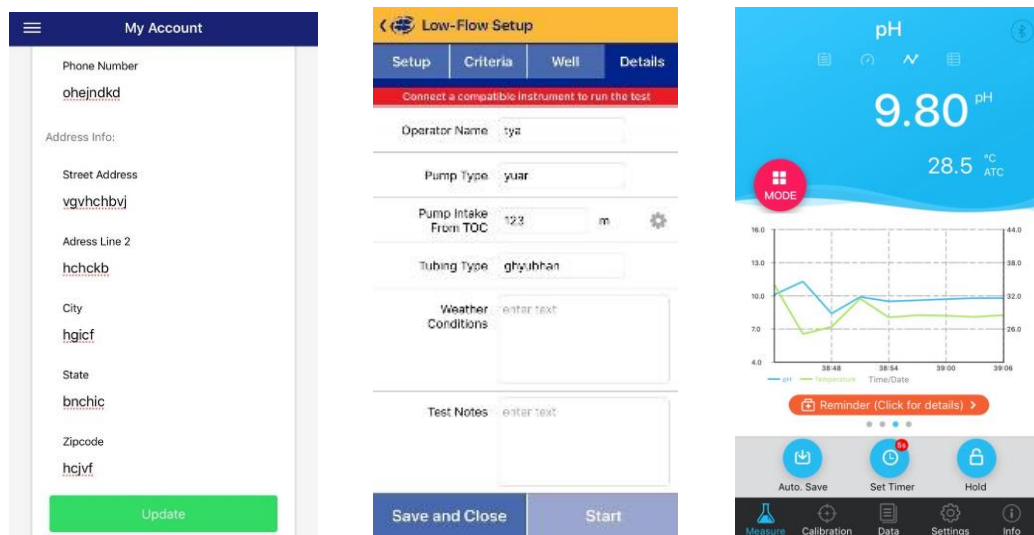


Fig. 9. Help Users With Errors

HELP AND DOCUMENTATION

According to Nielsen (1994), it is necessary for systems to provide help and documents that should be easy to search. The mobile application of water detector makes effort to provide user who have problem with water quality and water intake data. For VU Situ, users can call the tech support for any requirement or question related to the apps problems such as the data or features. The contact information is available and notable in the menu bar of the VU Situ mobile application. Besides, they also have FAQ menu bar which is the menu bar for question that frequently ask by the users. The questions are from users and the answer will be provided by VU Situ operator or worker. While for ZenTest they does not provide any instruction, contact or even FAQ question on the mobile

applications but the users can set an alarm or reminder for any activity for example to remind the preset range of our water PH values. It also allows user to check for the data through powerful cloud-based data management. Compared with the VU Situ and the Zen Test mobile application, the WaterBot offers stronger support for the users. Apart from sending questions to the service representative, WaterBot provide ticket support to the users and also FAQ session on the menu bar. Ticket support means customer experience related job—allowing your business to create, update, and hopefully resolve any issues your end-users might have. This might help users to ease their problem related to the WaterBot mobile application. . The enquiry service provided by the WaterBot mobile application is very supportive and convenient.

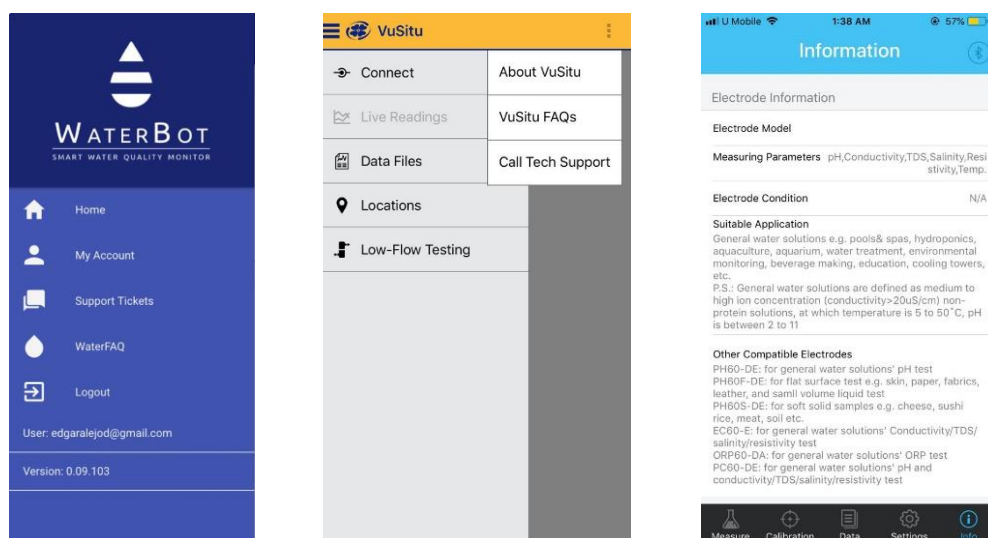


Fig. 10. Help And Documentation

DISCUSSION

SUGGESTIONS ON IMPROVING THE WATER QUALITY DETECTOR APPLICATION

Based on the results of our comparative study, we discovered that the water quality detector application mobile application has good design features and three features need further improvement as assessed based on the usability heuristics. Our assessment result is listed at Table 2.

First, the these three mobile application should provide an improvement on the context of visibility of system status. ZenTest application should improve the mobile application by making it able to inform users provide manual to instruct such as manual user. ZenTest must have the manual function such as VuSitu and Waterbot as shown in Fig. 1. Moreover, all three application must provide search bar or search navigation. The application must provide search bar with the icon that can make interactive communication with the user and applications by typing only the keyword. Secondly, match between system and the real world also need in improvement especially in WaterBot and ZenTest application. In this two application shows not clear function in the status, which makes users misunderstand. The developer must use the simple word that user can understand especially the users. Moreover, the usability that needs to improve is user control & freedom. In Waterbot, the application must have pop out confirmation before logging out account to make sure the user confirmation to log in the application. In Waterbot and ZenTest should have the "reset" button during signing up account to

make correction in mistaken information to key in the personal data.

Furthermore, consistency & standards also the priority be need to improve in this three applications. WaterBot should "emergency button" on certain page that user could have a good time to remember and recognize the symbol to undo a certain process. Besides, error prevention in WaterBot and ZenTest must provide extra platform for the data file saving to prevent any loss from occurring. Equally important, in these all three application must have help users with errors. In improving these three application should have the component that show the indicates wrong parameter or specification. The application must popup the error message box to show that some reading are be mistaken or not. The improvent also need in suggesting any solution in the application to help user with error. The user can find the solutions to overcoming problems.

In addition to the above suggestions, which are developed based on the finding of the comparative study, we would also like to suggest VuTest, WaterBot and ZenTest to consider providing more functions in the mobile application. During the evaluation, we discover that the WaterBot and ZenTest mobile application offers fewer services than VuTest. Thus, VuTest may consider the better application in water quality detector service.

CONTRIBUTIONS AND LIMITATIONS

This study has important contributions to both academics and practitioners. For academics, this study

provides, as far as we know, one of the first research studies on the usability of mobile water quality detection applications. Given the relatively short history of mobile water quality detectors, this study gives researchers an idea of how to use a usable heuristic framework (Nielsen, 1994) in the context of evaluating the use of mobile water quality tracking applications. For practitioners, our findings also give them a better idea of the design of mobile applications to provide similar water quality detection services such as biological studies. As with other research, this study has its limitations. The main limitation is that it is the only Zen Test that can be studied in depth because this app provide an app trial session compared to two others apps that don't provide a trial session.

However, we think that the mobile application design between the three applications is very different in the main menu section. The functionality and data displayed are also different between the three applications namely ZenTest, WaterBot and VuSitu. In addition, this study is research-based and subjective. For the purposes of future research, we plan to carry out the next phase of the project using research studies that focus on usability. We want to gather feedback from users on the usability, feasibility and advantages of this mobile mobile application. Through user response the app can be upgraded to better applications. Besides, this setting enables us to measure the perceptions of users about mobile site usability and see if it can be complemented our findings through the usability heuristics framework (Nielsen, 1994).

Usability heuristics	Zen Test	VuSitu	WaterBot
Visibility of system status	- Display services application to keep users informed. - Does not have manual to instruct. - Do not inform users of the search bar or navigation.	- Display services application to keep users informed - Do not inform users of the search bar or navigation. - Have manual to instruct.	- Display services application to keep users informed. - Do not inform users of the search bar or navigation. - Have manual to instruct.
Match between System and The Real World	- Show "Low-Flow Testing" in the status, which can make users misunderstand. - Can provide information in a logical ways.	- Uses simple wordings that users familiar with. - Can provide information in logical ways.	- Show "Support Tickets" in the status, which can make users misunderstand. - Can provide information in logical ways.
Error Prevention	Doesn't provide extra platform for data file saving and only using developer database.	Provide extra platform for the data file saving.	Doesn't provide extra platform for data file saving and only using developer database.
Help Users with Errors	- Cannot indicates wrong parameter or specification. - Cannot suggest any solution.	- Cannot indicates wrong parameter or specification. - Cannot suggest any solution.	- Cannot indicates wrong parameter or specification. - Cannot suggest any solution.
Help and Documentation	- Provide testing session using virtual detectors. - Provide less support to the users. - Information of application. Provided.	- FAQ session. - Contact information is available. - Provides guidelines. - Information of application provided.	- Provide the best support the users. - Contact information is available. - Can directly contact services representatives. - Provides guidelines.
Users Control and Freedom	- Provide "Emergency Exit" button. - Has pop out confirmation before logging out account. - Absence of "reset" button during signing up account.	Provide "Emergency Exit" button.	- Provide "emergency exit" button - Does not have pop out confirmation before logging out account - Absence of "reset" button during signing up account.
Consistency and Standards	Produce consistent layout.	Provide consistent layout	- Produce consistent layout - Absence of "emergency button" on certain page.
Recognition than recall	- The position of the icon and page name is easy for user to recognize. - Highlight of the selected page in the menu list makes user easy to know which page been displayed.	- The position of the icon and page name is visible and easy for user to recognize - Provide less recognition about the page selected in the menu list	- The position of the icon and page name is easy for user to recognize - Provide less recognition about the page selected in the menu list
Flexibility & efficiency of use	- Offers variety data view function. - Advanced data view by selecting which data to display.	- Offers variety data view function. - Advanced data view by selecting which data to display.	- Minimum data view function. - Display only limited data that already been setup by the developer.
Aesthetic & minimalist design	Produce the simplest design with complete and relevant information.	Produce a simple design with relevant information	Produce a simple design with relevant information

Table 1. Summary of comparison between 3 water quality mobile application.

CONCLUSION

Heuristic evaluation and benchmarking methods are used to evaluate usability of the HKUL mobile website. Evaluation results indicates that the water detector mobile application works well in all three application has good performance in 4 usability heuristics (Nielsen, 1994), including (i) Flexibility And Efficiency Of Use , (ii) Recognition Rather Than Recall , (iii) Aesthetic And Minimalist Design , (iv) Help And Documentation. However. We also note that there is room for improvement for the following issues as all three mobile application is : (i) Visibility of Status ; (ii) Match Sys & World ; (iii) User Control &

Freedom ; (iv) Consistency & Standards ; (v) Error Prevention ; (vi) Help Users with Errors. At the end of the study, the paper provided some suggestions for better application development. Finally, we also discuss the theoretical contributions and practical implications of this study, the limitations, and future of the research.

For further research and application development, we will develop the Water Detector mobile application to provide better service to communities in the country. In addition, ongoing studies will be conducted for this application to achieve a good standard of application quality for overseas consumption marketability.

Performance	
Good	Need Improvement
▪ Flexibility And Efficiency Of Use ▪ Recognition Rather Than Recall ▪ Aesthetic And Minimalist Design ▪ Help And Documentation	▪ Visibility of Status ▪ Match Sys & World ▪ User Control & Freedom ▪ Consistency & Standards ▪ Error Prevention ▪ Help Users with Errors

Table 2. Performance in all three mobile applications

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