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INITIAL DESIGN AND EVALUATION OF WESIHAT 3.0 FOR OLDER ADULTS

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ABSTRACT

User Experience (UX) is important in the interaction between humans and computers. It includes user`s satisfaction of the use, efficiency, and effectiveness. A good and acceptable design of an application is also important especially for older adults with impairment. The pilot study was conducted to evaluate the acceptance and usability of healthcare of designed mobile application named WESIHAT 3.0 among older adults. We conducted a survey using System Usability Scale (SUS) to obtain initial feedback on the developed prototype before we further refined it. Ten older adults aged above 50 years of age were recruited in this study. We aim to get an earlier insight of user satisfaction and acceptance on the early design interfaces before further improvement being made. The result from SUS score was 66.00 which indicated an average acceptance level. Refinement and recommendations were listed for further improvement. Participants agreed that the design is simple and easy to use, but there are still some parts of interaction that are considered complicated for them to use. The outcome of the study has potential to provide a technological support to the older adults to get knowledge on healthy lifestyle. This innovation was in line with the national policy on empowerment in technology usage to improve quality of life of older adults.

Keywords: *Usability, Older Adults, Interface Design, System Usability Scale*

1. INTRODUCTION

The development of technology and industry has become very complicated. Enthusiastic content enhances user interaction and experience. Users have experience that involves their perception of the benefits of using a product. User experience is the subjective feeling of people when they use or interact with products, services, or websites. User experience design is the strategy of delivering users with good experience, simple, intuitive interaction, high productivity, and pleasant emotions. It also involves the amount of value that users will obtain from a product or service.

Usability is defined as the ability of the system to meet the needs of users with five attributes of assessments namely: learnability, efficiency, memorability, errors, and satisfaction. Meanwhile, according to the International Standards ISO 9241-11 [1], usability is the extent to which a product can be used by specified users to achieve the target set with effectiveness, efficiency, and satisfaction.

User evaluation needs to gain positive user experience and better usability with the product. Understanding of the usability will improve user satisfaction, mainly for users with limitations such as the older adults. User evaluations require positive user experience and better usability of the product. An understanding of usability will increase user satisfaction, especially for users with disabilities such as the older adults.

In many ways, it would be beneficial to provide healthcare services through mobile technology that includes many users. Extensive mobile health applications are currently being developed for older people [2]. [3] indicates that senior citizens are interested in learning more advanced smartphone apps. The work by [4] discusses the use of touch screen communication in the design of educational food program for older adults. Findings show that most of the older people believe that educational toolkit is useful in delivering nutritional and lifestyle information.

Due to ageing, older people face additional obstacles for using the mobile application interface

as compared to younger people [5]. It could be due to the physical disabilities, cognitive problems, and inexperience in using computers. However, the process of gaining experiences, is also part of cognition from a general point of view and can be treated as cognitive issues [5]. Medical problems are caused by visual impairment, haptic degradation, and limited hearing. Presbyopia, cataracts, age-related macular degeneration, chronic open-angle glaucoma, and diabetic retinopathy are the five most common causes of visual impairment in the older adults [6], [7].

The issues of interacting with technology among older adults has been discussed by previous studies especially on healthcare [3], [5], [8]. In fact, there are design principles and guidelines for older adults when designing for this population [9]. Aging is a worldwide phenomenon of which there is a rapid increase in the older adult's population, associated with the rise of age related non communicable diseases including those related to cognitive impairment, of which reversible is being detected early. Innovation in mobile health applications detection has the potential to improve mental health of the aged population. However, the available applications in the market are mostly related to physical fitness and management of specific diseases, with those related to mental health focusing only on cognitive training.

Recognizing prevention of cognitive impairment requires a holistic approach, a web-based health information system for early detection of cognitive impairment (web-based version called WESIHAT 2.0) has been developed consisting of a valid screening risk indicators and evidence-based health, diet and psychosocial education and health dairy for self-empowerment. It started with a WESIHAT 1.0 which is a standalone desktop version of application. Although web-based WESIHAT 2.0 was well accepted by health professionals, caregivers, and older adults themselves, the usage was limited to professional assisted sessions and there is a need for further modification and refinement for further upscale so that it can be reached by a wider users' population. Thus, this study aimed to further upscale web-based WESIHAT 2.0 into WESIHAT 3.0 mobile version application for a wider outreach for early identification of risk of cognitive impairment and encourage sustainable behavioral changes through an interactive personalized educational package, named WESIHAT 3.0. This paper discusses our initial stage of user requirements in up scaling of components in WESIHAT 2.0 to a WESIHAT 3.0 mobile application; redesign the interfaces and content following a usability engineering development approach. Once it is fully upscale and developed, the WESIHAT 3.0 will be evaluated involving caregivers, older adults and health professionals with improved data analytics and monitoring features. This innovation was in line with the national policy on older adult's empowerment in technology usage so that this user group could improve their quality of healthy living.

The paper is divided into several sections. Section 2 elaborates on the relevant related work. It is followed by Section 3 that explains the development of mobile application for older adults with its design rationale and functionalities. Section 4 elaborates on the material and methods of the study that we have conducted, and section 5 discusses the results. Finally, is the conclusion and future work.

The major contribution of this paper is:

- Initial study that has been conducted and the findings contributed to a more concrete design rationale of mobile application that are based on user feedback.
- We follow iterative design of usability engineering cycle in the development process.
- The study also contributed to the ageing research particularly in the technology usage.
- The novelty of the work is on the application development process and its serve as a one stop center application for the older adults to gain knowledge on healthy lifestyle and societal well-being especially for major ethnicity in Malaysia.

2. RELATED WORK

Cognitive impairment for older adults is a major cause of morbidity and mortality worldwide and is substantially burdensome to the affected individuals, their caregivers, and the society in general. Early identification of the risk would allow appropriate and timely prevention and intervention measures before progressing to irreversible stages of dementia and Alzheimer's Disease. Recent studies indicated that the risk factors of mild cognitive impairment (MCI), which is a reversible, pedimented stage consist of unhealthy lifestyles, comorbidities, and psychosocial factors. Effort has been made to develop an intervention among older

adults' usage with the use of technology such as web-based application [10]. In the communities, family members and general practitioners are responsible for caring for older adults. Deterioration in cognitive function causes a higher degree of caregiver burden [11]. Although a multidisciplinary approach has been regarded as essential in caring for older adults with cognitive impairment GPs quite often serve as the sole healthcare provider in the communities [12]. There is a need to empower caregivers, family members and health professionals including GPs with tools for self-awareness of health education to initiate lifestyle and behavioral changes toward prevention of cognitive decline.

Innovation in mobile health information and applications have the potential to improve the physical and mental wellbeing, and to reduce the health care cost of older adults [3], [4], [8]. Example of such innovations are useful for health monitoring, health education, behavior change, falls sensing, mobile health alerts, communication, and connectedness. Most available mobile applications in the market focus on physical activities and fitness (MyFitness Pal, Fitnet, Tabata Timer), food modification (Calorie Counter, S Health, Nutrino) and self-management of chronic diseases (Heartwise blood pressure, mHealth). Technologies are changing the lives of the present cohort of older adults and are expected to give more impact in the future especially towards the Industrial Revolution era. Despite being important in terms of function in health interventions, most of the evaluation on the applications were conducted using small samples and over a short period of time [13].

As mentioned earlier, most web-based or mobile applications targeting to improve mental health and prevent cognitive decline among older adults focused on only assessment and brain training. It should be acknowledged that cognitive health is influenced by multiple factors such as psychosocial, health, lifestyles, and diet. Alzheimer's' Disease Risk Initiative (ADRI) has started a web-based application for early detection of cognitive impairment and health education to prevent cognitive decline [14]. However, the system is not mobile, and the content is only suitable for Caucasian. WESIHAT 2.0 comprised a screening tool for assessing risk of cognitive impairment and educational module for lowering risk of cognitive decline [15]. User acceptance analysis conducted among 71 respondents indicated that WESIHAT 2.0 is attractive and useful, however, its usage is confined to health professionals assisted sessions, as users prefer a more mobile version. Thus, there is a need to integrate the use of mobile technologies. Development of a mobile application to enable early detection of risk of cognitive impairment and empower individuals with sustainable approaches could reduce risk of cognitive impairment.

A vast amount of research has proven that the use of assistive technologies and information communication technologies (ICTs) which addressing the physical, cognitive, and social aspects of ageing, have the potential to encourage more physical activities among older adult and subsequently increase their quality of life. However, previous studies show a lower degree of technology adoption among senior citizens due to cognitive decline and vision impairment that cause interactions with the user interfaces become rather difficult and cumbersome [3], [4], [8]. Further, the ageing process could affect older adults' capability to interact effectively with the standard graphical interfaces. Good visual and motor coordination (which many older adults no longer possess) are required to read displayed information and selecting links to other web pages. Therefore, a significant work is needed to design a user interface that can support the skills and abilities of this vulnerable population.

There are several significant barriers faced by older people when using technology. One major barrier is inappropriately designed technological guidelines [16]. Most computer interfaces are designed and developed according to the needs of people in the young and middle-aged groups who are familiar with computer technology. Senior citizens often struggle and force themselves to adapt to design guidelines that are specifically meant for younger users, and their success in adopting the technology varies with age and cognitive factors. New media are used particularly for health promotion, including interactive computer programs, mobile technology, television, and Internet applications using the World Wide Web [4]. Therefore, senior-friendly guidelines must be followed when designing technology for older adults to increase their acceptance towards the technology and thus usability goals can be achieved. A design process of usability engineering is a discipline that focuses on improving the usability of interactive systems. Usability engineering involves the testing of designs at various stages of the development process, with users or with usability experts.

The level of mobile device usage among older adults is dependent on design issues [3], [17]. Older persons used and had strong opinions on some advanced features of mobile phones. Besides, compatibility was the most important determinant of smartphone adoption among older adults in Malaysia. The studies have also revealed the preferred physical design of mobile phones for older persons. Older adults were able to capture basic requirements of a mobile phone preferred by older persons, prior to design, however surprisingly, studies which was conducted in Malaysia shows that mobile phone design and usage for older persons is not necessarily limited to or based on old style, out-of-date model and supporting only very basic calling functions. Based on Internet users survey also positively shows that the average age of older adults as an Internet users showed increment compared to 2014 data which significantly indicated that higher age group are joining the online community. This proves that senior citizens in Malaysia are willing to use technology if they are compatible and use suitable design.

3. WESIHAT 3.0 APPLICATION

WESIHAT is an acronym of a Malay word *Warga Emas Sihat* or Healthy Older Adults, is a name of an application that was developed purposely for the older adults. It started with version 1.0 (desktop based) and followed by version 2.0 (web-based). WESIHAT 1.0 was a touch-screen application on desktop, while WESIHAT 2.0 was a web-based senior-friendly application [18]. The current version WESIHAT 3.0 is a mobile-based application that can have wider outreach among the community dwelling older adult's population especially during the pandemic period. As for older adult's design interfaces, several approaches were considered such as larger font size and icons button for better visibility of older adults [18]. Therefore, an effort was made to improve the WESIHAT 3.0 application to make it easier for the use of older adults.

Several researchers had suggested different design rationale in a mobile application user interface to address the needs of older adults. Visual and haptic deteriorations were the two commonly considered problems when establishing design guidelines for the older people [19]. The font used in the interface design must be enlarged (12 to 14 point) and the preferred font was Sans Serif for easier reading of older adults [4]. Studies stated the older people could read faster with 14-point text as compared to 12-point text [18], [20] and the color contrast must be applied when designing. The background color should be different with the font color, for better vision of the text [18], [21]. Both specifications were suggested to overcome visual impairment issues.

WESIHAT 3.0, is a mobile application comprising a cognitive impairment risk calculator of which users were allowed to enter personal details and further answer ten questions in the TUA-WELLNESS screening tool, related to health and lifestyle that will automatically calculate the risk of mild cognitive impairment. User had the opportunities to further assess his/her scores and self-assess which aspect that needed improvement from the ten questions. Further, specific sections on menu planning allowed the users to know his or her calorie requirement and learn recipes of healthy meals. Finally, the health diary section allowed the users to enter his/her health profile and monitor the values over time. The modules in the application encouraged self-empowerment in early detection of risk of cognitive impairment and further motivated individuals to make sustainable lifestyle changes toward neuroprotection and healthy longevity.

The WESIHAT 3.0 mobile application consisted of several modules: the main page containing guides to improve memory, health diary, and healthy food (as shown in Figure 1). In the module of guides for improving memory, ten strategies were provided such as dietary management of blood glucose, blood cholesterol, ways to consume more fish, fruits and vegetables intake, practice of calorie restriction, participation in mentally stimulating activities, avoidance of alcohol and smoking, building good social network, be physically active, and conduct annual health check-up. On the other hand, Module 2 was the health diary module for recording the blood test results and blood pressure of older adults. They can monitor the readings as alert was given when values were beyond the recommended range. Module 3 was the health food diary that contained healthy recipes that can be consumed by the older adults (Figure 3). WESIHAT 3.0 was developed to empower the older adults towards healthy living. In addition, WESIHAT 3.0 mobile application had videos demonstrating senior-friendly exercises for better fitness.

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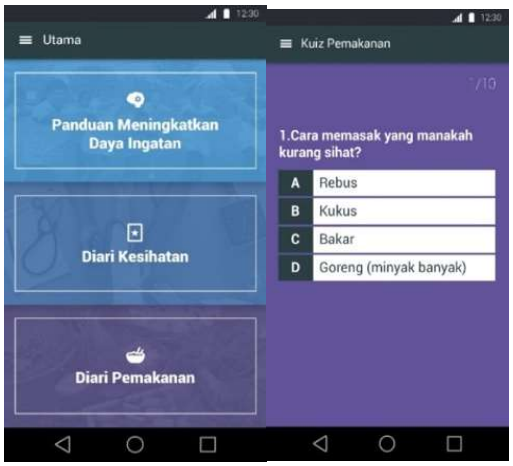

Figure 1: Wesihat 3.0 Screen Design Interfaces

Figure 2: WESIHAT 3.0 Interface Design For Module 1

The proposed guidelines to help older adults with haptic deterioration problems were by designing large button and have adequate space. It would shorten the reaction time for older people and increase the effectiveness of the application [15]. The app should minimize the use of keyboard for interaction. This category of users was prone to make errors while using the touch screen application. Hence, elements such as pickers and checkboxes were recommended as alternative to help them use the app [22]. Instead of taps, the designer may use movements of drag and pinch.

Study conducted by [15] found that older people tend to prefer dragging and pinching on the touch screen application rather than tapping. Figure 2 shows the example of WESIHAT 3.0 mobile application interfaces that were designed for older people with haptic deterioration problems. Figure 3 shows example of screen interfaces of the module with large button and spacing, minimizing the use of keyboard and can use drag and pinch movement interaction.

Figure 3: Large Button Size And Spacing

The identification of risk of cognitive impairment can be identified early and faster through TUA-WELLNESS screening tool as opposed to other clinical based methods that require sessions with health professionals. A comprehensive holistic ten (10) points education to prevent cognitive decline, self-selected healthy menu and self-monitoring personal health dairy would encourage a sustainable lifestyle and behavioral changes through self-empowerment as compared to traditional approach of health professional centered approach.

Features of WESIHAT 3.0:

a. It is generic that allow individual to enter personal data at large number, through mobile application
b. Compatible with other mobile application or tool for physical fitness, brain game and chronic disease management
c. Rapid screening for cognitive impairment with TUA-WELLNESS screening tool
d. Menu planning according to major ethnicity in Malaysia
e. Design of user interfaces (UI) with senior-friendly design principles.

4. MATERIAL AND METHODS

Ten older adults' participants who consisted of two women and eight men aged above 50 years old were recruited for the evaluation study. The aim for the initial user study was to gain feedback on the newly developed prototype mobile application and the feedback were used for further improvement in the next iterative design process. Participants were given a set of questions of System Usability Scale (SUS) consisting of ten questions [8]. SUS was chosen because System Usability Scale (SUS) was a valid and reliable questionnaire [23]. The SUS questionnaire had five points Likert scale ranging from 0 to 4. For items 1, 3, 5, 7, and 9 the score was the position of the scale minus 1. For items 2, 4, 6, 8, and 10, the score was five minus the scale position. Whole system usability was obtained by multiplying the total contribution score by 2.5. SUS scores ranged from 0 to 10 [24]. The formula for calculating SUS score:

$$\text{SUS Score} = ((Q1 - 1) + (5 - Q2) + (Q3 - 1) + (5 - Q4) + (Q5 - 1) + (5 - Q6) + (Q7 - 1) + (5 - Q8) + (Q9 - 1) + (5 - Q10)) * 2.5)$$

Based on research, SUS scores above 68 was considered above average and below 68 was less than average. The classified scale was A (91-100 score), Scale B (81-90 score), Scale C (71-80 score), Scale D (61-70 score) and Scale E (0-59 score). SUS was an easy scale to manage so that participants can be used on small sample sizes with reliable results and can effectively distinguish between systems that can be used and those that cannot be used.

The participants were first asked to try the prototype with demonstration followed by questionnaires which were completed by the participants. Signed informed consent was obtained from all the participants. We briefly introduced the prototype and make a short demo on how it works. The prototype was installed to the participant's mobile phone. The participants were given ample time to explore the prototype. All participants were given a usability question (SUS). We then collected the form for analyzing the feedback from the participants. Evaluation using SUS may not be able to find out specific problems in the product or features in the application or product, but this can be one of the measures of how well the usability of the product or feature of the initial design application. The evaluation using SUS is meaningful at this stage to measure the usability of the initial design application. This study used SUS to measure the usability of the initial design of the prototype application and look for improvements in the future work.

5. RESULTS

Questionnaires represent all aspects of usability including interface design, reduction in the size of memory used by applications, features to communicate, and data integration [25].

Table 1: SUS Score

P	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	S
R1	2	3	3	2	2	3	3	3	2	3	65,00
R2	2	2	3	2	3	2	3	2	3	3	62,50
R3	3	3	2	3	3	3	3	3	3	3	72,50
R4	2	2	3	2	3	4	3	3	2	2	65,00
R5	2	3	3	2	3	3	3	2	3	3	67,50
R6	3	2	2	3	3	3	2	3	3	3	67,50
R7	3	2	3	2	3	3	3	2	2	3	65,00
R8	4	3	4	2	3	2	3	3	3	2	72,50
R9	3	2	3	2	2	2	2	3	2	2	57,50
R10	3	3	3	3	3	2	3	2	2	2	65,00
Average SUS Score											66.00

P: Participant; Q: Question; S: SUS score

The SUS score for each question is addressed in Table 1. The average rating of responses to each question shows that agreement with the positive aspects of SUS (odd numbered questions) is always higher than the neutral value. While the negative aspects of the SUS questionnaire (even numbered

questions) are higher than the neutral values found in numbers 2 and 4. Based on the questionnaire, it shows that the user experiences complexity aspects in some features in the system so that it requires help from others to use the applications of the system. Table 2 shows each usability questions with mean values indicating overall improvement is needed for the design.

Table 2: Usability Questions

No	Usability Question	Mean
Q1	I think that I would like to use this system frequently.	3.7
Q2	I found the system unnecessarily complex.	2.5
Q3	I thought the system was easy to use.	3.9
Q4	I think that I would need the support of a technical person to be able to use this system.	2.7
Q5	I found the various functions in this system were well integrated.	3.8
Q6	I thought there was too much inconsistency in this system.	2.3
Q7	I would imagine that most people would learn to use this system very quickly.	3.8
Q8	I found the system very cumbersome to use.	2.4
Q9	I felt very confident using the system.	3.5
Q10	I needed to learn a lot of things before I could get going with this system.	2.4

Based on the score of the SUS questions given to the participants, we found that the answers to the questions on even numbers had undesirable score because in the SUS questions, even numbered questions were expected to have low scores (Strongly Disagree) because it would affect the results of high SUS scores. It was found that participants felt complicated when they used the application (for question number 2). Participants also have problems with requiring other people in using WESIHAT3.0 prototype (for question number 4).

Although the trial using SUS is an instrument that is very easy to use, but SUS does not provide a solution for disclosing application flaws. Based on that the value obtained a mean SUS score of 66.00 was obtained which is closer to the average SUS score (68.00). Some participants mentioned that WESIHAT3.0 prototype is good for supporting older adults and become a resource of information for older adults. Some participants think that the application is still complicated because there are several modules that are not available and are complicated to use. Moreover, all modules are not displayed on the main page thus they feel confused at the beginning. We also get some qualitative feedback from respondents about the overall design. Some quotes from participant on overall feedback on this prototype are as follows:

"This application needs to be improved, especially in the food module. The language also needs to improve so that it can be understood by some older adults. However, this application is very helpful and good to use to record and share information about health of the food and activities that are carried out in our daily activities" [R9],

"Interesting…. It contains information for supporting healthy living "[R2]

"Need improvement on dietary menu because not all food restricted for me to take "[R7]

The feedback we get from participants indicated improvement in user interaction. Based on qualitative comments, an improvement in all aspects of the modules is necessary. Limitation of the study is the small number of participants and by only using the SUS questionnaire for usability initial data collections. Big data and analytics are also an emerging technology that could be implemented in the future in the system design. Large grow of dataset and database for medical applications will require high-dimensional dataset and the classification parameters will also be increased. Therefore, an extensive study requirement design is important [26]. The design of WESIHAT3.0 will be enhanced, and the user evaluation will involve more participants in the next repetitive cycle. The repetitive is part of usability engineering processes to ensure the usability goal is achieved. With more participants and results, statistical analysis such as ANOVA can be performed.

Some limitation arises while conducting the study which is the respondents that participate in the study. Since the study is at the earlier stage this seem appropriate feedback and there will be another iterative stage of development and refinement of the application. Thus, even though the samples respond is considered small, it will still contribute to the relevant findings of the study.

5. CONCLUSION

The strength of the study is by employing the user-centered design in the process of development of the WESIHAT3.0 from the early stage. By applying the usability engineering process from the early stage of design would inform a better design rationale thus the usability goal will be achieved.

More iterative process will be taken in the future for emphasizing the user in the design process. The findings showed a total SUS score was 66.00 which are still below the average (68.00) and needed improvement. SUS is an easy method for measuring usability. However, SUS is inadequate to reveal the shortcomings of the application and the system at the early stage. Based on the participant`s review, some features are still complicated and still require improvements.

Undoubtedly, in this era of ICT, IR4.0 and rapid development of mobile technologies, mobile application has the potential to be used to enhance quality of life of individuals and population including for older adults. The usage of mobile application in health promotion has a wider outreach, fast, accurate and standardized in content and approach. With increasing health awareness, such application has a great potential in wealth creation as user are willing to pay more for prevention, as diseases such as cognitive impairment if progressed to a later stage, would result in dementia and Alzheimer's Disease which is nonreversible and increase the health and social burden to individuals, families, communities, and the nation. Data gathered from implementation of the product or application can serve as a cognitive function registry that has the potential to be used further in need assessment for market to preserve brain health and prevention of cognitive impairment, using current approach of understanding data, such as Big Data analytics.

Future work for this initial evaluation is to improve the design of WESIHAT 3.0 based on user feedback. Another iterative design process will be carried out among the older adults with larger participants. Since this process of user requirement is iterative, the total number of participants will be repeated in the next process of redesign. User experience (UX) has an impact on a system that is given by participants in the form of how the evaluation of a system can be improved in the future for interaction with users according to older adult's user needs so that the system can be easily used by them for improving quality of life. Future research directions will investigate on the usage of the application in a more diverse older adults' population including the gender and ethnic. Some guidelines for the designer in developing the application with specific design rationale will be produced.

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