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MISMATCH BETWEEN OLDER ADULTS' EXPECTATION AND SMARTPHONE USER INTERFACE

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ABSTRACT

Smartphones have become ubiquitous communication tools for everybody, including older adults to stay connected with their family and access to information. However, mobile operators and developers mainly target the youngster cohort in mobile industry. With the rising ageing population, smartphone user interface and some mobile apps are not designed to cater the needs of older adults. This could hinder them from fully utilizing the smartphone functions and its services. A mobile-user interaction study using mixed-methods (questionnaire, interview and observation) was conducted to examine usability and user interface design issues of smartphone and mobile apps among 80 older adults in Malaysia. Four tasks design were 'making voice calls', 'using phonebook', 'installing a mobile app from Google Play Store', and 'using WhatsApp'. The results were analysed both quantitatively (for usability evaluation) and qualitatively (for interviews and observation). The usability result revealed that the 'voice call' task had the highest success task completion rate (83.44%), followed by 'phonebook' (70.16%), 'mobile app download' (63.13%) and 'using WhatsApp' (60.42%). Three themes were emerged from the qualitative thematic analysis, which showed a mismatch between older adults' expectation and smartphone user interface. A majority had never downloaded a mobile app before, and they had problems downloading it from Play Store. They perceived the Play Store feature as a place for children playing games. To close the discrepancy between user expectation and mobile design, the mobile designers and developers are required to consider the older adults' needs for better usability of smartphone user interface design.

Keywords*: Older adults, mismatch expectation, smartphone user interface, usability, design issues.*

1. Introduction

As Malaysia will become an aged nation in 2035 (Malaysia Healthy Ageing Society, 2012), there are increasing demands and needs from local ageing population to be addressed in different aspects of social-economic requirements, communication, transport and physical infrastructure to build a digital inclusive society. Due to better healthcare and improved standards of living, this implies that it is expected to be 9.8% or 3.3 million of the entire population by 2020 (Department of Statistics 2000; Mafauzy, 2000), and 23.6% or 9.6 million of the population in 2050 (Alfian, 2017).

The Malaysian Ministry of Women, Family and Community Development stated in the National Policy and Action Plan of Older Persons (DPTWEN, 2011-2020) that '*to create older persons who are independent, with dignity, high sense of self-worth and respected by optimizing their self-potential through a healthy, positive, active, productive and supportive ageing to lead a well-being life.'* As such, there will be an implication towards healthcare, transportation, housing, and also different demands of lifestyle for the ageing population.

Since the launch of Apple iPhone in 2007 marked as the beginning of 'smartphone' era, smartphones have become an essential ubiquitous tool for all walks of life (Hern, 2017). With the prevalent mobile retail shops promoting all kinds of smartphone brands, it leaves very little rooms for keypad-enabled phone to be seen in the shopfront. Thus, this leads to the situation where older adults are left with not many mobile phone choices. Eventually they have to gradually migrate to become *'silver'* smartphone users. However, the current mobile operators in Malaysia mainly target young adults (age 18-45) as their main consumer markets. In addition, most smartphone user interface and mobile apps are designed for youngsters and professional groups except some specific senior-oriented apps. Most of the time the older adults are struggling to learn and use their smartphones without proper guidance and help provided. Hence, the needs and requirements of older adults' cohort (aged 60 and above) have been sidelined in the mobile development process.

As a result, it is crucial for the older adults to use smartphones to stay in touch with their family, peers and children in terms of running their daily chores, keeping themselves updated and connecting to the mainstream society and also living independently. Older adults face challenges to switch from keypad-enabled feature phones to touch screen smartphones. This study aims to investigate usability and design issues of smartphone user interface for older adults.

2. Literature Review and Related Work

2.1 Problems Using Mobile Phones by Elderly

This study is intersected between human-computer interaction and interaction design domains. Numerous studies have been done on mobile phones and elderly. Previous literature described elderly as passive mobiles users, and they merely used their mobile phones for emergency and security purpose (Kurniawan, 2006); and males are frequent mobile users than female elderly (Kurniawan, 2008). Based on previous literature (Nasir, Hassan, & Jomhari, 2008; Wong, 2011; Azuddin, Abd Malik, Abdullah, & Mahmud, 2014; Wong, Ibrahim, Hamid, & Mansor, 2017), the problems faced by the elderly using mobile phones are (i) form factors and user interface (UI) of mobile phone device: rubbery buttons, small screen display, small buttons, colours, backlighting and text characters for viewing; (ii) cognitive decline: difficult to recall functions, having memory difficulties of remembering own mobile phone numbers, complexed menu arrangement; (iii) motivational issues: comfortable of using mobile phones for emergency only, not familiar of other smartphone functions except calling and SMS, fear of installing mobile applications, and getting help from family members (i.e. children, grandchildren); (iv) physical impairment or decline in motor skills, vision and hearing: eyesight problems in viewing messages and saving contact numbers, bulky shape and mobile phone to fit on hands; (v) circle of support: lack of guidance, support, or training from family members, friends or any experts. The older adults were afraid of pressing the keypad numbers wrongly and were not familiar with new interaction modes such as sliding or touching interaction mode. Some were not English-educated, and they preferred to switch the mobile system language to Malay or Mandarin. They were wary of exploring to use mobile banking as they afraid their money would be stolen or missing. The older adults perceived phone menu navigation as complicated with unclear instructions. They had no clue where to operate certain functions on the complexed menu design.

Nevertheless, these problems highlighted here are referred to the pre-smartphone era, which is keypad-enabled feature phone. However, the likelihood of this circumstance has changed with the introduction of smartphones. For instance, since touch screen is the interaction mode for smartphones, metallic or rubbery button on keypad-enabled feature phone is no longer relevant and applicable to the current smartphone form factor for the older adults. There were different issues and concerns for the older adults in using smartphones such as prone of typing errors on virtual keyboard, and small font size. Having said this, there are varieties of smartphone screen size available in the mobile shopfront these days. Older

adults are given more options of choosing their preferred smartphone screen size during the early smartphone era. As age increases, the older adults experience visual, audio and psychomotor declination. They previously complaint about the smaller screen size on their keypad-enabled feature phone. With the current smartphone UI, it allows for different viewing options on font size to change from small to super large. Some smartphones also allow to change setting from 'standard' to 'easy' mode for simpler UI on the overall smartphone screen display. Smartphones, which allow for all kinds of mobile applications download, open up new discoveries for everyone, especially for the older adults. The only concern is whether the older adults are confident and comfortable to download from either the Play Store (for Android phones) or App Store (Apple iOS phones) on their smartphones only. This indicates the needs to study usability of smartphone UI for older adults, which is the focus of this paper.

2.2 Smartphones Studies and Older Adults

There were substantial previous studies conducted on smartphones with older adults in the past decade. For instance, pointing performance of mobile screen was determined by size, space and location or the target and audio tactile feedback for elderly (Hwangbo, Yon, Jin, Han, & Ji, 2013); touch-screen smartphone is more suitable for elderly (Boulos. Wheeler, Tavares & Jones, 2011); navigation, interaction and visual design recommendation of mobile user interface for older adults (de Barros, Leitão, & Ribeiro, 2014), smartphone user interface and heuristic evaluation for older adults (Sano, 2017; Salman, Wan Ahmad, & Sulaiman, 2018); design guidelines and checklists for feature phone and smartphone comparison (Petrovčič, Taipale, Rogelj & Dolničar, 2018).

The situation has changed with the introduction of WhatsApp as communication mobile app. Previous studies revealed that WhatsApp is the main driver for the older adults to adopt smartphones due to family encouragement and peer pressure albeit in different countries (Rosales and Fernández-Ardèvol, 2016; Wong, Rahimah, Aizan, & Mansor, 2017 & 2018). Older adults perceive WhatsApp is a 'free' phone call as compared to the voice phone call feature using their smartphone. Interestingly, there is more urgent to attend to WhatsApp phone call than the phone voice call on their smartphone. One of the main reasons for them to keep busy and attach to their smartphone is the chat messages and media files sharing among their WhatsApp group, in particular they can still keep in touch with their family and relatives, alma mater schoolmates and other community groups. It reinforces relationship ties with others regardless geographical distance (Nouwens, Griggio, and Mackay, 2017).

2.3 Mismatch of User Expectation and System Design

Previous studies had demonstrated that mismatching between user expectation and a system design could lead to user frustration, and cause failure of system and product implementation in different ICT projects such as digital home (Bly, Schilit, McDonald, Rosario, & Saint-Hilaire, 2006), translation technology (Flournoy, & Callison-Burch, 2000), digital library system (Hill, Carver, Larsgaard, Dolin, Smith, Frew, & Rae, 2000), software (Petter, 2008). Therefore, the success of a software project was determined by three risk factors, which were failure to manage user expectations, misunderstanding requirements, and insufficient or inappropriate staffing (Petter, 2008). It was highlighted that failure to meet user expectations can affect the project and product or system success. If users of a system have improper assumptions of how the features of a system should be delivered, then there is a mismatch between user expectation and system design.

Norman (1998) in his *Design of Everything Thing* book mentioned the gulf of execution and gulf of evaluation in the Execution/Evaluation Action Cycle (EEAC) model, in which there was a 7 stages of action depicting how users perceiving a system design and whether it matches user perception and expectation. If a system design and its functionality matches with user's expectation and falls under the user's mental model, which is what the users believe about the system at hand (Nielsen, 2010; Norman, 1998; Hutchins, Hollan, &

Norman, 1986; Razak et. al., 2018). As a result, the user will not experience unmet expectations that typically yields frustration and dissatisfaction with the artefact. It was found that three strategies for managing user expectations were user involvement, leadership and trust, which could reduce the risk of software project failure (Petter, 2008).

To reduce the gap of mismatching between user expectation and a system design, interface metaphor plays an important role in facilitating the learning process of transforming existing knowledge from the real world to a new or improved system design (e.g., desktop design, Web-based or mobile platforms). It was crucial for the system designers to select an appropriate metaphor that suits the user's language and comprehension to avoid the pitfall of mismatch between user expectation and system design. As such, mapping between metaphor and its functionality is imperative for intuitive user interface of a system design. For instance, a designer may like to use the term *'directory'* as an organisation of file systems in a system design. However, from the user's perspective, the meaning of *'directory'* is usually referred to a document that stores names, addresses, and telephone numbers. The rationale behind an appropriate metaphor is to provide a more realistic representation from real world objects and concept that facilitates user recognition of the metaphor. The real world model (i.e., artefacts, and process) often shape the user's expectations with the functionality that associated with the system design (Alty, Knott, Anderson, & Smyth, 2000), which is also familiar to the user existing mental model.

2.4 Prior Experience, Semantic Memory and Icon Design

It is important to learn that pictorial representation or visual appearance of icon design plays an important role to communicate the meaning beyond language barriers on the user interface (UI) of computers or mobile devices. Zhang, Xue, Shen, Chen, Shao, Zhou and Zhou (2016) studied the effects of semantic memory on icon complexity. It was found that familiarity influences the semantic memory on icon complexity. Interestingly, other studies also found that visual appearance, location and function of a system or product user interface are the criteria that provide feedback for the users to determine the next possible action on the UI (Blackler, 2006; O'Brien, 2010). Similarly, familiarity based on prior experience was highlighted to trigger the users' semantic memory of recognising certain icon design on a user interface design. Semantic memory is one type of long-term memory, which denotes knowledge retrieval about the world without reference to any specific events (Zhang et al., 2016). It is a more structured record of facts, meanings, concepts and knowledge about the external world that one has acquired (Mastin, 2018). It refers to the general factual knowledge, shared with others and independent of personal experience of the spatial or temporal context in which it was acquired. Semantic memory is considered abstract, relational and is associated with the meaning of verbal symbols such as capital cities, function of objects, vocabulary, understanding of mathematics, and so forth. This relates to the appropriate use of metaphor and terminology for system design in the earlier text. Thus, the icon design on smartphone such as WhatsApp, Play Store, Line, Facebook are considered as abstract icons. The users have to learn the meaning of the icon functions. It is difficult for users to recognize such icons without prior experience, especially for the older adults who are born before the digital era. They have no clue and difficult to associate their semantic memory if the icons are not familiar with their cultural context.

In a nutshell, since the older adults face the challenges of adopting and familiarizing with the smartphone user interface, this paper aims to examine usability and design issues of smartphones user interface among the older adults in Malaysian context.

3. Research Methodology

We had conducted a mobile-user interaction study using mixed-methods approach, which involved survey (quantitative), observation, interview and verbal protocols (qualitative).An embedded design (Creswell and Clark, 2011) was used in which qualitative data are embedded within a major design of mobile-user interaction study The reason of choosing a

mixed-methods approach with the embedded design strategy was to provide a better understanding of quantitative data (survey) through the supportive qualitative data of interview and observation. The mobile-user interaction study was conducted from May and July 2016 at Malaysian Research Institute on Ageing (MyAgeing^{tm}), back then called as Institute of Gerontology.

3.1. Selection of Participants and its Criteria

The study focused on young old adult cluster (Fisk, Rogers, Charness, Czaja, Sharit, 2009), aged between 60 to 74 years old, own and use a smartphone for at least 3 months. The reason of targeting this cohort because they are considered as potential *silver surfers*, who are more willing to adopt smartphones with improved technology innovation as compared to old-old adults' cohort (aged 75 years old and above). This cohort also serves as high potential adopters and smartphone customers for mobile industry due to the rising ageing population. Once the older adults have adopted a smartphone and familiarise with the functions, they will continue using the device.

As this study is focused on healthy and active ageing population, we exclude participants who suffer from severe physical, visual, or cognitive impairment to be participated in this smartphone study. Our study also aimed to include the three major ethnicities (e.g. Malay, Chinese and Indians) in Malaysian context. The participants were mainly recruited from University of Third Age (U3A), a lifelong learning program for senior citizens.

3.2. Apparatus and Location

The apparatus used to conduct the mobile-interaction study was an Android smartphone. This was based on the result of the feasibility study (Wong et al., 2017) implying Android mobile operating system (OS) was the most popular, favourite and affordable smartphone device as compared to other OS like Apple iOS and Windows phone.

As a result, the apparatus use for this study was Samsung S7 Edge. The Samsung S7 Edge used Android 5.0 Lollipop version of mobile user interface design. The reason for selecting this Android smartphone model was because none of the participants had any prior experience or used it before so that there is no bias of pre-perceived conception of the smartphone user interface for all. Another reason of choosing this device was due to its large 32 GB internal memory capacity to store the mobile screen interaction video captured by Mobizen screen capture software into its phone internal memory. In order to treat the selected smartphone device as a total new and fresh perception consistently across all the participants, the model was also just newly launched in 2016.

We conducted the mobile-user interaction study at a quiet seminar room at U3A and USER (Usability and User Experience) lab at Multimedia University.

3.3. Tasks

The selected tasks for this study were based on the previous result from the mobile survey (Wong et al., 2018). The 4 main tasks were (i) making voice calls (ii) using phonebook (iii) installing a mobile app from Google Play Store, and (iv) using WhatsApp. The first two tasks were based on the most frequent features use on a smartphone for older adults. WhatsApp was chosen as the most popular mobile app and also the main factor for the older adults adopting smartphones. The difference of a smartphone and keypad-enabled feature phone is that the former allows for using mobile apps on the device. So, we included installing a mobile app using Play Store as a task design to find out whether the older adult know how to use this feature and their experience of using it. Table 1 depicts the 4 main tasks and the sub-tasks.

Table 1: The four main tasks and sub-tasks for the mobile-user interaction study.

Task 1: Voice calls Sub-task 1: Making a call. Sub-task 2: Retrieving calls	Task 2: Phonebook Sub-task 1: Adding a contact with a phonebook. Sub-task 2: Making a call from phonebook contact.
Task 3: Installing a mobile app Sub-task1: Go to Google Play Store to download a torchlight mobile application. Sub-task 2: Start initiating the application.	Task 4: Using WhatsApp Sub-task 1: Sending a message using WhatsApp. Sub-task 2: Sending photos using WhatsApp. Sub-task 3: Sending an audio file using WhatsApp.

3.4. Procedure

We received an ethical approval from the University Ethics Committee for Research Involving Human Subjects. A screening process was first conducted based on recruitment criteria. During the mobile-user interaction session, the participants were sought for their permission to get involved in the study by signing a consent form. They were informed that the whole sessions would be audio-video recorded for the purpose of data analysis. Their names would be coded in anonymity to protect their identities.

During the pre-task session, the participants were asked to fill-up an Affordance Questionnaire (pre-task) for their demographic profiles, perceived expectation on selected icon design on smartphone user interface. An interview was also conducted to find out their profiles and their smartphone experience. Next, they were asked to perform 4 selected tasks. They were allowed to skip the tasks after several attempts if the specific task was not successfully carried out. After interacting with the tasks, the participants would fill up the Affordance Questionnaire (post-task) to assess their perception and experience interacting with the previous 4 tasks on the smartphone. During the debriefing session, a follow-up interview was also performed to find out insights about their user experience and frustration using the smartphone. The entire session took around 45 to 95 minutes depending on the individual's ability and involvement.

The Affordance Questionnaire was written in three main languages, which were English, Bahasa Malaysia and Mandarin, to cater for language requirements for older adults in Malaysian context. The questionnaire had done backward and forward translation from English to Bahasa Malaysia or Mandarin and vice versa. As the researcher (the first author) was conversant in speaking in three languages, the session was conducted in English, Bahasa Malaysia, Mandarin (or Cantonese dialect).

3.5. Measures

We refer to ISO9241-11 (International Organization for Standardization, 1998) to measure usability metrics for quantitative study. For this study, we only consider the performance metrics, which are effectiveness and time. For the effectiveness score, we measure the task completion rate (in percentage) for each task, where 100% is considered as successfully completed, and 0% is fail to complete the task. The average task completion rate for each task is based on the total values (in percentage) of all the sub-tasks completion rate, and divide them in average.

The study also conducted a Device Attitudinal Survey adopted from O'Brien's study (2010). The purpose was to find out the overall user perception of older adults interacting with the Samsung S7 Edge smartphone user interface. The survey used a 7-point semantic differential scale, which was categorized into 3 sections, including 'enjoyment', 'ease of use', and 'appearance'.

3.6. Interview

As mentioned in Section 3.4, interviews were conducted during the pre-and-post task sessions. During the pre-task session, the purpose of the interview was to find out the participants' profiles and reasons that motivating the participants of adopting their smartphones, and also their experience (positive or negative aspects) of using their smartphones. During the post-task session, interviews were conducted during debriefing session. The purpose is to find out the participants' overall perception and experience after interacting with the 4 given tasks. Here the interview questions during the debriefing session:

1. Do you remember how you first became aware of the [Feature 1]? (Prompt: did someone recommend it to you? Did you read about it somewhere?)
2. When you were interacting with [Feature 1], how well would you say this feature work? Does it behave the way you expect it to be? Does it give you any problems during your interaction?
3. How easy is the [Feature 1] to use? Do you need any special knowledge to use it? Can you straight away use it without any prior knowledge?
4. When you first look at the [Feature 1 i.e. phone call] icon, how well does the visual elements help you to perform the task (e.g. making a phone call)?
5. How well do you think this [Feature 1] icon located at the right place on the smartphone screen?
6. What would you suggest to improve for this [Feature 1]?

3.7. Methods of Analysis

As the study employed mixed methods, the results were analysed quantitatively and qualitatively. We conducted quantitative analysis using a statistical software SPSS 23 for descriptive analysis (mean, frequency). Before that, we had also conducted the normality test and all the data showed normally distributed.

For qualitative analysis, we first transcribed and translated all the interviews into text description. We then used a qualitative data analysis software, NViVo 12 Plus, to analyse the interview transcript and also the mobile-user interaction videos for video analysis. The interviews were coded and there are several themes emerged using thematic analysis (Bernard & Ryan, 2010).

4. Findings

This section illustrates the demographic profiles of the participants and followed by the quantitative and qualitative results of the mobile-user interaction study.

4.1. Demographic profiles of Participants

There are 80 young older adults recruited for the study, which were 40 males and 40 females, aged between 60-74 years old. The average age of the participants is 65.63. The participants comprised of Malay (27.5%, n = 22), Chinese (58.8%, n = 47), Indian and others (13.8%, n = 11). The reason of the proportion of Chinese participants are higher than Malay is because Chinese consists of the highest number of membership at U3A that time.

In terms of occupation, 77.4% participants (n = 62) were retired, 11.3% (n = 9) were still working, and 11.2% (n = 9) have never worked before. There are 4 groups of monthly income categories, which are 'no more income' (38.7%, n = 31), 'less than RM1000/US257 to RM2999/US722' (26.3%, n = 21), 'RM3000/US723 – RM4999/US1204' (23.8%, n = 19), and 'RM5000/US1205 and above' (11.2%, n = 9). Due to the U3A membership and its location at Selangor state, a majority received 'tertiary education i.e. college, university' (50%, n = 40), followed by 'upper secondary education' (40%, n = 32) and 'primary and

lower secondary education' (10%, n = 8). For proficiency of languages, almost all participants can understand English, and Bahasa Malaysia (the national language of Malaysia). Surprisingly, although the percentage of Chinese participating in this study is the highest among other ethnics, half of them are well-versed in Mandarin language. This shows that this group of participants are unique because those who come to join U3A lifelong learning program received higher education and have interest learning. Thus, their backgrounds and language criteria cannot be applied across to other elderly population in Malaysia.

In terms of problems faced by older adults using smartphones, more than half of the participants (58.2%, n = 46) complained the smartphone battery discharged very quickly as compared to their previous featured phone. Another problem highlighted that the 43% older adults generally thought their 'fat' fingers that causing them typing errors on the virtual keypad of the smartphone mobile screen. Other problems (46.8%) indicated that their smartphone easily get hanged, fear of downloading unknown software or accidentally touch on virus software into their mobile, baffling with notification and unsure whether to upgrade the software. In general, the older adults expressed their desire of learning and seeking help and guidance from someone, especially not all are adventurous in exploring a new feature.

4.2. Quantitative Analysis: Overall Task Completion Rates

The results of task completion rates for all the four main tasks were reported in our previous work (Wong et al., 2018). Table 2 depicts the details of the 4 main tasks and its sub-tasks' completion scores. The result shows that voice calls feature receives the highest task completion rate (83.44%), followed by phonebook (70.16%), installing a mobile app (63.13%) and using WhatsApp (60.42%).

Table 2: The four main tasks and sub-tasks for the mobile-user interaction study.

Tasks and Sub-tasks	**Percentage (%)**	**Tasks and Sub-tasks**	**Percentage (%)**
Task 1: Voice Calls	**83.44**	**Task 3: Installing a mobile app**	**63.13**
Sub-task 1.1: Making a call	80.63		
		Sub-task 3.1: Go to Google Play Store to download a 'torch light' mobile app.	64.38
Sub-task 1.2: Retrieving a call	86.25		
		Sub-task 3.2: After downloading, open the torch light application	61.88
Task 2: Phonebook	**70.16**	**Task 4: Using WhatsApp**	**60.42**
Sub-task 2.1: Adding a contact with a phonebook	71.88	Sub-task 4.1: Sending a message using WhatsApp	81.88
		Sub-task 4.2: Sending a photo using WhatsApp	63.13
Sub-task 2.2: Making a call from phonebook contact. Call Wong CY from the phonebook	68.44		
		Sub-task 4.3: Sending an audio record	36.25

4.3. Device Attitudinal Survey Result

In order to gauge the user perception of older adults using the Samsung S7 Edge, a device attitudinal survey was conducted (Wong et al., 2018). The result was shown in Figure 1. The mean for the 3 main categories of device attitudinal are (i) Enjoyment (5.26), which consists

of 'boring-fun', 'unpleasant-pleasant', 'negative-positive', 'painful-pleasurable', 'dull-exciting', 'foolish-wise', and 'unenjoyable-enjoyable', (ii) Ease of use (4.73), which consists of 'difficult-simple', 'boring-elegant', and 'complex-easy' and (iii) Appearance (5.75), which comprises of 'unattractive-attractive', 'repulsive-delightful', 'ugly-gorgeous' and 'plain-striking'. The highest scores are 'unattractive-attractive' item (5.75), 'ugly-gorgeous' (5.71) and 'plain-striking' (5.69). It looks like these 3 items are inter-related. The high score could be influenced by the Samsung S7 Edge apparatus, which was covered by a gold colour casing that appears to be an elegant look at that time for the participants.

All the scores are above 5 (from 1 – 7 scores) except 'difficult-simple' item (4.73) and 'complex-easy' (4.55) under 'Ease of Use' category. This implies that the participants were somehow struggling using the smartphone. Due to their social desirability to look 'good', older adults in Malaysia generally did not like to give lower scores, or expressed honest feelings when it comes to filling up questionnaires. They wanted to portray themselves as being 'capable' of using smartphones. In reality, the observation and scoring are contradictive to each other. Many were struggling using the Samsung S7 device itself, especially some advanced features like sending photos, recording audio files using WhatsApp, and adding contacts on the phonebook.

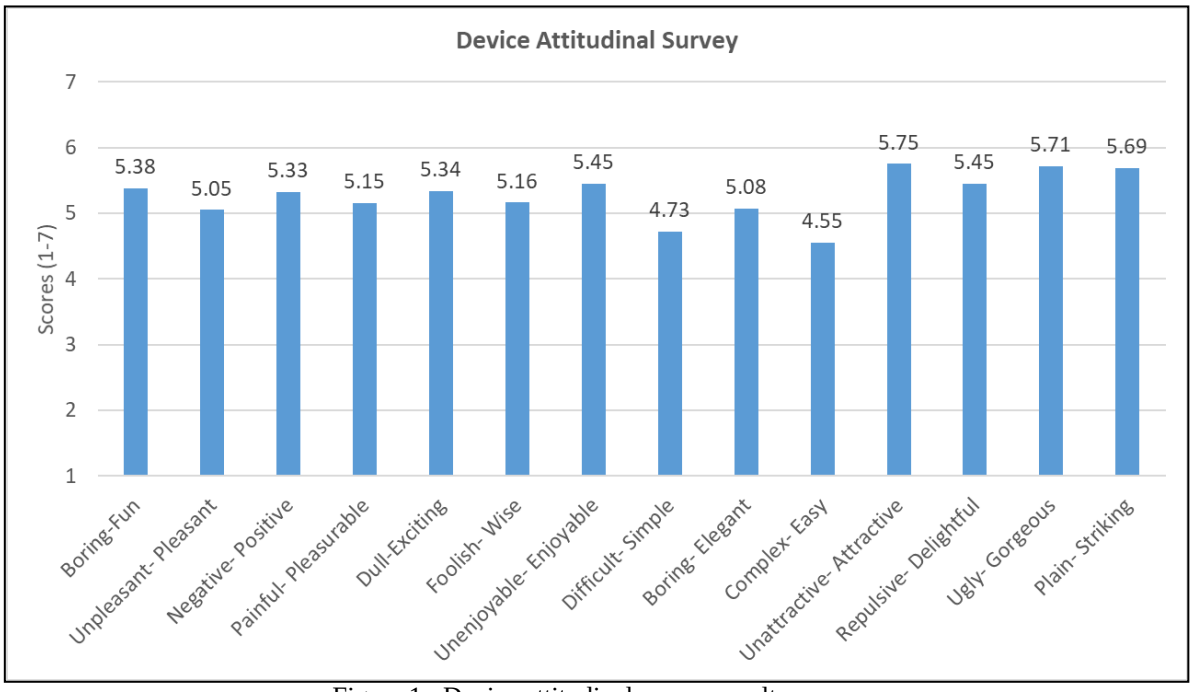

Figure 1: Device attitudinal survey result.

4.5. Qualitative Analysis: Interviews and Observation

During the post-task session, we had conducted an interview to further investigate older adults' perception and experience of interacting with the 4 tasks during the debriefing session. The interview and observation data were analysed using a qualitative analysis software, NVivo 12 Plus. The main theme of the interview and observation qualitative analysis is 'mismatch between older adults' expectation and smartphone user interface (UI).' There are 3 sub-categories that derived from the main theme, which are, (i) visual appearance of smartphone UI, (ii) visibility of icon location, and (iii) functions of icons.

(i) Visual Appearance of Smartphone UI

Visual appearance of a smartphone UI is important as the first visual contact for the users to perceive and take further action on its function. In general, almost all the participants could identify the phone call icon and successfully made a phone call. However, the older adults were struggling to find the 'hidden' and obscured phone keypad icon, which was located at the bottom right on the Samsung S7 Edge (Figure 2). Some participants had several attempts and succeeded, but some eventually gave up without making a call. They expressed their needs that they preferred a direct dialling page rather than having extra steps of finding the 'hidden' and 'not so intuitive' keypad design to make a phone call. The metaphor of the phone keypad icon is not 'direct' and it did not resonate with the older adults' mental model, which posed a problem for them perceiving the function of the phone call keypad design.

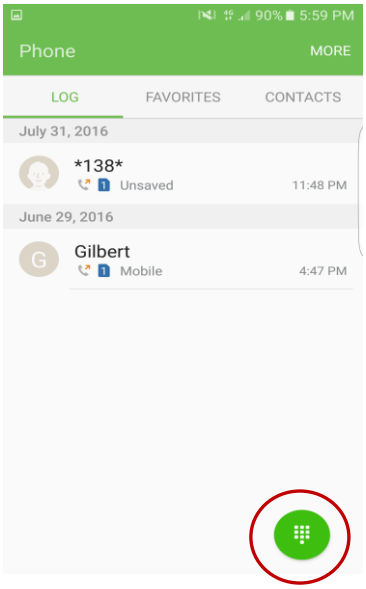

Figure 2: The phone keypad icon located at the bottom right on Samsung S7 Edge (circle).

(ii) Visibility of Icon Location

The location and visibility of an icon is important for users to navigate through the mobile pages. Otherwise, users need to find deeper layers to reach the destination, or search for the desirable item. For instance, Figure 3 shows the default first page of Samsung S7 Edge. WhatsApp is located at the top row, second right, Play Store is placed next to WhatsApp at top row first right, whilst Phone icon is located at the bottom left. Figure 4 shows the default second page. Contact is located at the first row, left on the second page.

As a majority of the older adults did not download and install mobile apps from Play Store, they expressed there was no need to place *Play Store* icon at the first page, and it should be located at the second page. Instead, the *contact* icon is as important as the *phone* icon, and it should be placed next to the *phone* icon. Thus, the location of an icon reveals the visibility and its frequent use icon for its selected features. It shows a mismatch of older adults' expectation and their perceived importance of icon location on a smartphone.

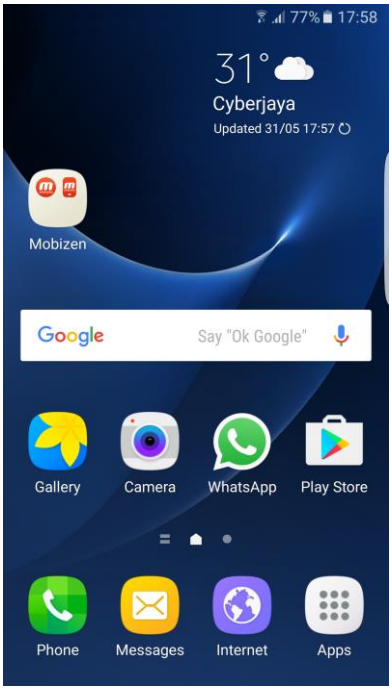

Figure 3: The default first page of smartphone screen UI for Samsung S7 Edge.

Figure 4: The default second page of smartphone screen UI for Samsung S7 Edge.

(iii) Functions of Icons

There is a mismatch between older adults' expectation and smartphone UI. A majority of the older adults experienced difficult time dealing with task 2, 3, and 4 (in particular the sub-task of recording and sending an audio file using WhatsApp). Most of the smartphones were passed down from their children or other family members to the older adults. Almost all the mobile apps had already installed in the device itself. Thus, the older adults had no clue how to use certain features, especially Google Play Store. They were advised and 'warned' by their children not to simply download the mobile apps if they were not clear what to do with it.

Apart from some basic features like phone call and WhatsApp, almost all the mobile applications were already installed into their smartphones. They had no clue and were not given proper guidance how to use and operate their smartphones. As a result, it was problematic for the older adults for first time exploring using Play Store to download a mobile app. For instance, a female older adult (69 years old) expressed that she had no clue what to do with it, and expect the Play Store like a game store because the name itself is 'play' store. Another male participant (72) even lamented that *'for my age, I don't need a game. It is for kids.'*

Interestingly, quite a number of participants expressed the same perception of Play Store. Many older adults were confused and unclear of the Play Store function (Figure 3). In general, the nomenclature of Play Store is misleading to many older adults. Many perceive Play Store as *'playing games', 'shopping bags', 'luggage for travelling'* and something for kids with fun and entertainment. They have not thought it as a place to download mobile applications. This highlights there is a mismatch of user expectation (perceived from the visual design) and the external material world (icon design of Play Store).

5. Discussion

This section discusses about the results from quantitative and qualitative analysis from the usability study. The findings of the qualitative analysis, including interview and video observation of how users interacting with the tasks, support and complement the result of quantitative analysis from the usability evaluation study. The study provides the user insights of how older adults perceived smartphone UI interacting with the given 4 tasks.

In the Section 4.2., the usability result revealed that the task completion scores for 4 tasks are decreasing for subsequent tasks. Task 1 of 'voice call' has the highest task completion scores (83.44%) as compared to the other 3 tasks simply because making a phone call on smartphone is the fundamental feature and also the icon design of phone or voice call (as shown in Figure 3 on the bottom first left at Samsung S7 screen page) is common and familiar to the older adults. It also has the similar concept of making a phone call function based on their prior experience in keypad-enabled feature phone.

For the second task of 'phone book', many older adults stuck at the first sub-task of adding a contact with a phonebook. They were not familiar with the process of adding a contact. Once the older adults could not add a contact, it yields the issues of finding the contact in WhatsApp for Task 4. That is one of the reasons why some of them could not send a message using WhatsApp although they could do it easily in their own smartphone. This reveals that the older adults are not familiar with the UI and navigation system of adding the contact on the testing device. Unlike Apple iOS, there is no standard UI process across for all the Android phones.

5.1. Mismatch between User Expectation and WhatsApp Audio Recording Function

Some users were also frustrated and eventually gave up the sub-task of recording and sending an audio file using WhatsApp. It was considered as a new feature for the audio feature on WhatsApp. Through the video analysis, it shows that there were many recurring technical flaw and user interaction issues of the audio recording features. For instance, the older adults expected to 'press and hold' the audio icon at WhatsApp to talk for audio recording before 'releasing' the button (Figure 5). As the instruction was not made vividly clear to the older adults, they just 'pressed' the WhatsApp audio icon once and quickly released it. Some had no clue how to record the audio feature and eventually gave up. Some attempted few times by sending the audio file by trial and error. However, they could not replay the audio file as having a technical flaw. Despite successfully sending the audio file, this could be due to the audio file was recorded less than 2 seconds and it could not replay. This shows a serious usability issue of the WhatsApp audio feature (where the study was conducted in 2016). This situation correlates with Norman's Execution/Evaluation Action Cycle (EEAC) model of highlighting the disparity of user expectation and the real world object.

We observed that the audio feature has improved its usability and functions lately. When a user holds on the WhatsApp audio feature longer, a 'lock' sign will appear on top of the audio icon, it means the user no longer needs to keep holding the audio icon to speak over it. However, the older adults expected by pressing the audio icon once and quickly released it means the recording has started taking place. As there is no clear UI and instruction provided, this usability problem can trigger user frustration. This clearly implies a mismatch of icon function and older adults' expectation.

Figure 5: Technical flaw of WhatsApp audio file.

5.2. Mismatch between User Expectation and Nomenclature of Icon Design

Apart from this, a substantial number of older adults could not find the torch light mobile app and installed on the smartphone. As highlighted in our previous studies (Wong et al., 2018), most of the older adults received their smartphone as a pass down device from their children or spouse. The mobile apps were already installed and they were not guided how to use Play Store to download a mobile app. Thus, the older adults did not have the prior knowledge of how to install a mobile app from the Play Store. This is shown in quite a low success rate (63.13%) of task completion for Task 3. In addition, the visual appearance and nomenclature of the Play Store icon were unclear to the older adults. Generally, they perceived it as 'playing game', 'game store', 'shopping bag', 'suitcase', 'travelling carrier', which is totally opposite from the real function of Play Store. The term of Play Store is an abstract concept and the older adults need to learn the convention to understand its meaning and function. For older adults who were not born as digital native, they did not have the prior knowledge stored in their semantic memory in perceiving the icon. This is supported by the studies done by Zhang et al. (2016) highlighted how semantic memory influencing the icons complexity. In addition, it is also important of how familiarity plays a role in deciding the icon recognition (Blackler, 2006; O'Brien, 2010). This yields a serious usability problem and design issues that there is a mismatch of older adults' expectation with the Play Store icon design and its function as mentioned in earlier text (Norman, 1998; Nielsen, 2010). These user insights are crucial to take into consideration of how visual appearance of icon, location and also the function on smartphone user interface is important for the possible next action for users. It is suggested that the mobile developers and designers to improve their usability and interface design issues as highlighted.

6. Conclusion

In a nutshell, the findings of this usability study implies a mismatch of user expectation with the smartphone user interface for older adults. As such, the smartphone user interface components, which are visual appearance, visibility of location and function influence the perception and possible actions taken for the users. As opposed to the youngsters, the prior knowledge of older adults are stored in their semantic memory, thus the icon design needs to incorporate their needs and expectation. Otherwise, this yields to user frustration of using the smartphone. As there are rising ageing population, smartphone has become a necessity and an essential communication tool for older adults to live independently and stay active ageing with communities in society. Thus, it is crucial for mobile developers and designers to design intuitive smartphone user interface based on older adults' requirement.

This paper focuses on the usability studies and mismatched expectation of the smartphone user interface for older adults. Future studies will discuss the affordance matrix of smartphone user interface as a whole.

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