

Guidelines of User Interface Design for Elderly Mobile Applications: A Preliminary Study

¹Aslina Baharum, ²Nurul Hidayah Mat Zain, ¹Aryanto Taharudin,

³Rozita Hanapi, ¹Azali Saudi and ¹Rayner Alfred

¹Faculty of Computing and Informatics, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia

²Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Jasin Campus,
Merlimau, Melaka, Shah Alam, Malaysia

³Faculty of Business Management, Universiti Teknologi MARA, Sarawak Campus,
Shah Alam, Malaysia

Abstract: In this research paper, it will explore the issues regarding the user interface design for elderly mobile phone users and what the factors lead to the limitations of using the mobile applications. Besides, this study also discuss about a mental model, what is it means and how we are going to assess a mental model by using a few methodologies that act as an approach to solving the problem faced by elderly when using particular mobile applications. Moreover, the mental model will work as a vital element in this research because it will affect the interface design that we will develop in future progress. Hence, this research will be an age-related matter as it will only focus on what are the elderly expect in interface design so that hopefully it will increase the elderly's usability and learnability when using a mobile applications.

Key words: Elderly, User Interface Design (UID), mobile application, guideline, Malaysia

INTRODUCTION

The era of mobile technology has been so much sophisticated and evolved rapidly over the past few years. The popularity of mobile devices such as tablet computers and smartphones dominates all age ratings from younger to elderly (Park *et al*, 2013). This statement moves along with the statistics from Malaysian Communications and Multimedia Commission (MCMC) where the handphone users from elderly ranged from 60-64 years old increase from 1.9-2.8% in 2012-014, respectively. The increased usage of handphone users in Malaysia indicated that the elderly also open up their mind to learn new technology if they gain value from it. However, the rapid change of technology such as the invention of smartphones and tablets now a days make elderly find it difficult to keep it up with new technology environments and new practices has become one of the problems. Furthermore, there are a lot of issues that need to be considered before developing the mobile applications (apps) that available for all user groups, especially for elderly people. Their age, social stigmatization, prerequisites and mobile apps skills are taken into considerations for mobile apps development. Hence, in this research it comes with assumption with the

expected result is user interface design for elderly more likely to have a simple user's mental model pattern for mobile apps.

Definition of mental model: The main goal of this research is to find the appropriate guidelines for User Interface Design (UID) based on a mental model from elderly in mobile apps development. Hence, the definition of the mental model is notable which encapsulates the theory, framework and interface design at the end of the research. The mental model can be defined into two perspectives; psychological and also in software development. Psychologically, gentner mentioned that mental model is a representation of some domain or situations that support understanding, reasoning and prediction. Besides, another definition that could be best to use is from Johnson (1983). He said when a human perceived his/her surroundings, his/her vision yields a mental model of what things are there in the scene in front of them. In software development perspectives (human computer interaction), the mental model is a knowledge of the component of a system or it also means the knowledge that forms the basis for users being able to construct a reasonable action and explanations about why the set of actions is appropriate (Baharum and Jaafar, 2013;

Carroll and Anderson, 1987). When software designers create new products or applications, they are expressing ideas that they believe will stimulate specific end-user experiences. According to the definitions that have been explained before also by taking into consideration of two different mental model perspectives, it can be concluded that mental model is a representation of what we can be perceived on the mobile apps with the reasonable actions and have an explainable reason of why the actions are executed.

The mental model in mobile apps: The mental model has been used in previous research mostly in the field of psychology and Information Technology (IT). Vala *et al.* (2011) proposed a method of collecting mobile apps user's mental models with MeMo2Ap app. It was designed to give a simple implementation, easy preparation of test scenario, context focus, distributed test deployment, results from visualization and simple evaluation.

Making a portable application with usable, appealing and particularly justifiable configuration can give higher deals and developing quantities of clients while poor user experience makes an application unsuccessful (Baharum, and Jaafar, 2014). During the application design phase, the conceptual model of the apps is created. This conceptual model produces the system image with which the real user interacts. Inaccurate system image does not support the creation of the correct mental model of the user. With respect to user mental model linked with specific application screen, it is possible to reorganize and redesign problematic parts and redo the tests. Comparing the results between the first system image and the redesigned system image is possible to highly improve the user experience. After the testing, a successful threshold for each test screen should be set up. If the success percentage of the test screen is lower than the threshold, design improvements are necessary. Another test should contain the improved test screen and again the success percentage is evaluated.

From the studies, it is learnt that the method being used in order to get an effective mental model is from a MeMo2Ap testing application that can emphasize the easy implementation, easy preparation of test scenario, context focus, distributed test deployment, results in visualization and simple evaluation. The test scenario is executed when there is a new testing project runs the test scenario in real-time, producing, so that they can assess the mental model from test users. Incremental testing is just like prototyping, where user means to test the application design with test screen as described above and then they need to iterate the design if the percentage of successfulness is lower than the threshold, then they

need to improve the design iteratively, until they meet the tester's requirements, then the interface design will have improved.

User interface design for mobile apps: Indeed, there is a huge gap of the differences of interface design for mobile application and web application, since they both have their own advantages and disadvantages (Baharum and Jaafar, 2014). It is better to know what is the important part of interface design other than an icon, colour and contrast in the mobile apps development.

A mobile phone device basically contains a User Interface (UI) system, a Real-Time Operating System (RTOS) and several hardware devices. The UI system accepts input events and executes corresponding functions, reacting to such external events as user input, connections and changes in handset status. The RTOS provides resource management services to the application system including multithreading management, communication, synchronization and Interrupt Service Routines (ISR). Most mobile phones contain a panel, keypad, Digital Still Camera (DSC) and Global System for Mobile communication (GSM) system. The UI, Operating System (OS) and hardware devices must work together to ensure proper mobile phone system operation. Any changes in an OS or hardware device require immediate UI redesign and reimplementation. This is usually a constraint for system designers and programmers while such kind of changes must be made. To coordinate this process, Vala *et al.* (2011) proposed a generic software framework for designing mobile phone systems architectures.

This study proposed a new approach in developing the interface design, only to help the UI designers in reducing the workload of UI programmers. Thus, with the less workload for UI programmers, the work efficiency increases (Baharum and Jaafar, 2013). Moreover, the significant of this study with this flow diagram of UI process is this research will follow this process as a conceptual model in order to develop the mobile application.

The components of interface design in mobile apps will refer to these common interactive elements (Garrett, 2010). This is be the main focus of this study, where elderly need to choose and give their own preferences for each of the elements given.

The interface design later will follow the components and will be categorized according to their functionality (e.g., radio buttons and dropdown lists can only one option at the same time while date picker will choose the date).

The “elderly” people: The terms “elderly” have been debated over many years. The terms “elderly” and “older” people may vary in most organizations, countries, personal opinions, etc. In Malaysia the classification of elderly for those who are 60 years old and above. However, Thane (1978) early stated that old age occurred between the ages 45-55 years for women and between the ages of 55-75 for men. Despite of that when the “elderly” used in this study, it refers to the elderly people who have experience with mobile devices (smartphones, tablets) and age ranged from 45-60 and above years old, by referring Razak *et al.* (2012) which using samples of eight peoples of elderly with the age range of 52-68 years for the study of mental model of elderly of reminder system. In terms of the number of respondents, Leung *et al.* (2008) obtained 18 samples of elderly with similar mobile application experience. Thus, this study will take an estimated number of 30 respondents with professions either in government, private or self-employed sectors and also take into account for the previous researcher’s definitions with the term “elderly” and to abide the research scopes given.

The limitation factors of elderly: Leung *et al.* (2008) study of limitations of elderly leads to the development of this research. Limitation factors of elderly and the design approaches solution.

Limited factors of elderly

Eye vision: Elderly need to have a big and clear fonts in order to read, avoid animation could lead them confused and reduced their readability with the interface design.

Colour vision: Elderly cannot take much colour in one application. Thus, they need a limited number of colours in one interface in order to increase the comfortability when using the applications.

Memory: Elderly cannot remember things for a long time span, hence the system would need to reduce the navigational design when dealing with application for elderly improving the mobile interface.

Attention and simplicity: Distraction over a mobile phone for elderly could make irritates elderly from using the application

Design approaches solution

Improving graphical interface: Improving the size and position of the icons as well as the labelled icon is higher readability of the icon given.

Multi-layered interface: Reducing complexity of the application would lead to more focused on the most

important function of applications, hence reducing functionality layer will make elderly to increase their usability to the system

Improving the mobile interference: Improving such as interface with a larger display would help elderly to support elderly with some extra guideline in the mobile interfaces

All of the limitations above are crucial factors of the development of the research, excluding the limitations of memory, because it will involve with the navigation design which is out of the scope of the study. These factors are taken as a benchmark for the prototyping but we need to develop a questionnaire regarding use of fonts (size and type), the size of icons (affects eye vision). These types of questions are to determine what are the elderly preferences and thus hopefully developing a good mental model for the upcoming application prototype.

Elderly and mobile apps (studies on non-essential design): The non-essential function applications can be best described by Yusof *et al.* (2014) and he also stated the non-essential functions are unpopular yet desirable and can be improved in an elderly mobile phone. This list of applications will work as a basis for the implementation of prototype applications later. The applications include:

- Calendar the calendar can help in stores the appointment with the doctor and friends. This also can prevent the elderly from forgetting the appointment cause by reduces of cognition abilities
- Notes this can help in putting the information about the short-term notes such as shopping list
- Reminder alarm this will help the elderly to remind them about the appointments and the other information. This application also can help them in remembering them the time to taking the medication
- Emergency calls this will help them to call the emergency department if the emergency happened
- Contacts store important phone addresses from families, relatives and neighbours

All of the non-essential applications will be reviewed with three examples of mobile apps according to their type (calendar, notes, contacts, etc). These applications will be included in the questionnaire later so that elderly can choose the most required application before we can develop a prototype only to a specific application.

MATERIALS AND METHODS

A research methodology is a process to find answers, maybe it is not conclusive but is desperately to

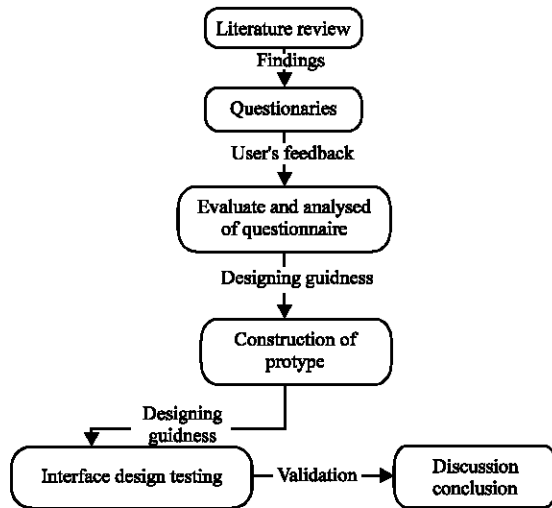


Fig. 1: Research method

find because of the necessity, the urgency to find the solution for that particular problem. Hence, a step-by-step method of research is vital throughout the research procedure. In this research, the following methodology is used (Fig. 1) from literature review until the discussion.

Quantitative method using mental model: The questionnaire designed based on the literature reviews that have been provided. The questionnaire will consist of two sections which are section A and section B. Section A will ask about the demography questions (gender, age groups, religions, etc.) while section B will ask about their opinion related to mobile apps interface design and eventually to determine the mental model based on their preferences from options provided in the questionnaire. Face to face techniques are used in this method by guiding elderly to help them to understand the question given with explanations about the user interface elements exist in the mobile application and this is because to prevent any lack of data or corrupted results such as the missing questions to be answered in the questionnaire.

RESULTS AND DISCUSSION

Participants and procedures: A total number of 30 questionnaires was distributed to the fitted elderlies with age ranged from 45-60 above years old, regardless of their occupation (government or private sectors, self-employed) and have the experience with smartphone and tablet. The questionnaire is done by using face to face questionnaire approach to prevent the invalid and lack of data from every elderly respondent (some of question left blank or being confused about). Besides, keep in mind that this research is only focused on the

elderly people who owned and having experience using mobile apps. The questionnaire consists of two sections; A and B. Section A is a demography question and section B is a question regarding to the several components (fonts, size of fonts, colour brightness, size of icons) and also elements (radio buttons, dropdown lists, search box, message box) of interface design that typically exists in a general mobile apps on Android platform. The respondents need to decide which components they think suitable and the elements they want in a general use of the application.

Questionnaire-section A (demography questions): The first section of the questionnaire reveals that 40% is the majority of respondents aged between 45-50 years old who owned a smartphone or tablet, following by 27% of respondents aged between 51-54 years old, 33% of respondents aged between 55-60 years old and the lowest are none from 60 years old respondent. This is due to the fact that elder people in Malaysia retire at the age of 56 years old, so it is not out of ordinary to get these results. Next, the employment status of elderly is divided into three parts which are from government sectors, private sectors and self-employed job. The 53.3% of respondents are work with government while 13.3% of respondents work in private sectors. The rest of them that occupied 33.4% of respondents are self-employed. Since the elderly are in the sub-urban area, Kota Kinabalu, Sabah, the SPM background holds the highest respondents which covers 33.3% of respondents while both diploma and bachelor hold 23.3% of respondents.

Questionnaire-section B (assessment of mental model): This study will discuss the elderly preferences on their opinion with regard to the interface design of the mobile apps. Basically, the construction of this questionnaire is based on the previous researches. Besides, there is an addition of the interface design elements which are Radio buttons, dropdown lists, calendar view date picker, spinner view date picker, tooltips and also message box.

Non-essential applications: According to Yusof *et al.* (2014), the non-essential applications yet so important for elderly are calendar, notes, reminder alarm, emergency calls and contacts. Based on the results, contacts application have been rated for the most popular application for elderly with a total of 76.7% of respondents while the second place of popularity would be 10% of respondents chose emergency call application both reminder alarm and notes applications share 6.7% of respondents and none for calendar application. This shows that the contacts is the most used mobile application to the elderly.

Frequency of mobile application usage: There are 15 respondents using the non-essentials application every time (every minute, seconds) while both of using the non-essential applications four to three times a day and four to three times a week, shared a same amount of respondents that cover 6.7% from the total of 30 respondents.

Font categories: In this questionnaire, the font categories is divided into two parts which are Sans-Serif and Serif (Bernard *et al.*, 2001). The sans-serif fonts usually used are Verdana and Arial, where the Serif fonts would be Times New Roman and Georgia. Furthermore, based on Table 1, Arial font covers the majority with 40% of respondents, followed by Verdana which is 33.3% of respondents, 20% for Times New Roman and the lowest popularity will be 6.7% covered by Georgia.

Font sizes: This supported by Bernard *et al.* (2001) where the font sizes between 12-14 pt always been the most suitable fonts size since they also have a higher readability for the elderly. Besides, the results from the questionnaire are interesting in which font size 12 pt is being the major choice of respondents which covers 46.7% of respondents followed by size 13 and 14 pt with 40% and respectively.

Icon sizes: Icon sizes for mobile applications, only for general applications usage is usually available with 96, 64, 48 and 32 dp icon sizes. The majority selection was 48 dp with 65%, followed by 16% for 32 dp, 14% for 64 dp and 5% for 96 dp.

Radio buttons and dropdown lists of UID elements: The radio buttons and dropdown lists provide the same function yet different approach of selecting the option. Even the functionality is the same, however, the most appropriate design for elderly would be the dropdown lists since it has a little drop down animation and it is easier to scrolling up or down whenever we want to search names, positions, races, departments and genders. The dropdown lists is the most selected by the respondents with the majority of 60% of respondents and 40% of respondents are selecting radio buttons element in the interface design.

Calendar view and spinner view of UID: This is the basic of date picker that exist in any mobile apps development. The calendar view theme date picker provides an attracting interface just like a real calendar while spinner view theme date picker have simpler interface design, users need to scroll it up or down to get the desired date or just simply type it using their touch keypad.

Table 1: Type of fonts for elderly (Bernard *et al.*, 2001)

Sans-Serif fonts	Serif fonts
Arial (40%)	Times New Roman (20%)
Verdana (33.3%)	Georgia (6.7%)

Tool tips of UID: Tool tips are under information components in which it provide small information about other elements (item on the screen), hence it will help the user to have a better understanding to the mobile apps. A number of respondents is equal (50%) when they choose to either want to use tooltips that provide small information about the elements of interface design of mobile apps or not.

Message box of UI design: The importance of message box is to warn or alert the user about the next action that could change any function or information in the mobile application. Thus, it is considered as a very vital interface while alerts the user about the state of the mobile application. With all the results above, this study able to provide a summary of the guideline based on elderly mental model.

The guideline of assessing elderly mental model; type of contacts

Desirable non-essential applications: This is because they think it is important to have phone address to their related persons so that they consistently have in touch with them.

Frequency of the application usage:

- Everyday
- This is because they think it is important to have phone address to their related persons so that they consistently have in touch with them

Font type:

- Arial
- Elderly mostly would prefer Arial as the type of fonts because it does not have fancy “tail” at the end of the alphabet hence it increase their readability on the mobile application

Font size:

- 12 pt
- The majority of elderly would prefer font size of 12 pt even when size font of 14 pt because it will be too big for the user to see the content

Icon size:

- 48 dp
- 48 dp is a small icon that available on smartphones or tablet. The elderly mostly not need a bigger button and icon size because for them they only need a functional button to touch on the screen

One-choice selection of interface design elements:

- Dropdown lists
- The simple design yet still useful to the elderly, it can drop down options for choosing the action that users want

Date picker:

- Calendar view theme
- Is the elderly's choice because of its colourful and giving pleasant to the eye whenever they see the interface element

The necessity for tooltips: The necessity for tooltips is favourable among elderly according to questionnaire since it will show the small information about the sub-elements of the interface design

The necessity for message box: This element is compulsory to be in the prototype to alert the users whenever they navigate the mobile application wrong and this message will help them to alert about what is going on in the mobile application.

CONCLUSION

Mental model as defined as a knowledge of the component of a system or it also means the knowledge that forms the basis for users to be able in constructing a reasonable action and explanations about why the set of actions is appropriate (Baharum and Jeafer, 2014; Carroll, and Anderson, 1987). When software designers create new products or applications, they are expressing ideas that they believe will stimulate specific end-user experiences. In this research we want to identify the basic guidelines based on mental model of elderly on mobile applications, because, the elderly finds it difficult to keep it up with new technology environments and new practices because of rapid change of technology such as the invention of smartphones and tablets now a days are so advanced for them to become updated (Baharum and Jeafer, 2014). Furthermore, there are many software products that majorly focused on and designed to assess young people or designed by younger developer experience (Phiriyapokanon, 2011). This happens due to the mobile apps for elderly is not the popular norm for the designer to only design for the younger people. The limitation factors of elderly prevent them to use the mobile application such as limited eye vision, short-term memory and also colour blindness. The use of mobile application needs a lot of hard work if there is a disability when using the mobile applications. This including the small font size is hard to see, the colours are too bright or too low for

elderly and also the varying consistency of the interface design make elderly hardly to remember the previous pages of mobile application's interface.

Lastly, the sole purpose of the research study is to make a guideline for developers or programmers to develop a mobile application, more focus on interface design that is suitable for elderly. Therefore, this research has been conducted to identify what is the guideline based on mental model method of elderly what is the preferred application and also what are the criteria of user interface design that need to pursue of in order to make sure there is need to expand the usability of the elderly user on this new technology. Hopefully, this research able to give some idea on what is the mental model and how it is important it is to understand the importance of mental model through our life. The research successfully discovers a mental model preference in user interface design, specifically to input elements of Android devices. Thus, this research can help to guide the other researchers or developers to develop the mobile application that suitable for the elderly user and by applying the preferences of elderly. In the future, interesting areas to explore are the new preferences for children's mental model or specific elements of user interface such as navigation design and user experience and how we can relate this software development with the mental model. Furthermore with the mental model preferences for elderly obtained in this research, it can be used as a guideline for developers and designers to develop the mobile apps. Hence, the development of mobile apps is not only focuses on the younger teen, or middle aged men/women but opened to elderly that also want to pursue the improvement way of life with the aid of mobile application in their hand.

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